HEALTH AND NUTRITION IN INDIA

by the same author

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War and Agriculture
Problems of Rural India
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India: What Now?
Indian Peasant and his Environment
The Making of Federal India

HEALTH AND NUTRITION IN INDIA

by

N. GANGULEE

With a foreword by
Sir John Orr, K.B.E., F.R.S.

There is but one temple in the world,
and that temple is the body of man.
—NOVALIS

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To

Pandit Jawaharlal Nehru and other leaders of the Indian National Congress, who have undertaken the responsibility of shaping a national policy, based upon directed economy, for the rehabilitation of my Country, where '*for every three mouths, there are only two rice bowls*', this book is respectfully dedicated.

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ILLUSTRATIONS

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FOREWORD

by Sir John Boyd Orr

M.D., D.Sc., LL.D., F.R.S.



The 'newer knowledge of nutrition' has opened up a new era in the history of medicine comparable in importance with the era introduced by the work of Pasteur, which led to the control of mar
gery.
of the
advance in human welfare. Mankind will get rid of deficiency diseases such as beri-beri and pellagra, which still take a heavy toll of human life in many countries, and be freed from many physical disabilities, much indefinite ill-health and poor physique, which are prevalent in all countries.

We have already begun to apply the knowledge with most encouraging results. Thus, for example, in the United Kingdom, due partly to the spread of the knowledge, partly to a rise in the standard of living and partly to the supply of milk and other protective foods, free or at reduced rates to mothers and children of the poorer class, there has been a marked improvement in the national dietary. Compared with pre-War years, the consumption per head of some of the protective foods has increased by over 50 per cent. Accompanying that improvement in nutrition, there has been a corresponding improvement in health. The worst cases of malnutrition, such as gross rickets and scurvy in children, have almost disappeared. Infant mortality has been reduced from 111 per 1,000 live births to 58 in 1937. The death rate from tuberculosis, which is so much affected by diet that it might almost be considered a disease of malnutrition, has been reduced by half. The expec-

tation of life at birth has been extended by as much as seven years. In addition to the reduction in mortality and morbidity rates and in deficiency diseases, there has been an improvement in health and physique, most marked in the case of children. The children of to-day are both bigger and of better physique than their parents were at the same age. While many factors have contributed, each to some degree, to this rise in the standard of health, the results obtained from feeding experiments on animals under controlled conditions and the results of tests in which deficiencies in the diets of human beings were made good by the addition of protective foods without any other change in environmental factors affecting health, suggest that the improvement in national health is to be attributed mainly to the improvement in the national dietary.

A similar improvement in health, due to better feeding, is taking place in most civilized countries. Indeed, there is reason to believe that the rate of improvement in some European countries and the British Dominions is more rapid than in the United Kingdom. This improvement in the last twenty-five years shows how easily ill-health and suffering can be reduced and life saved.

But, though such a great improvement in feeding and health has taken place, the standard of health is still far below what it would be if every family enjoyed a diet fully adequate for health. Sir William Crawford, from the results of a recent investigation of family dietaries of all classes of the community, estimates that the food expenditure of about eight million people is still below the minimum standard of the British Medical Association. It is doubtful whether the diet of half of the population reaches the League of Nations' standard, which is not a minimum but an optimum diet.

The application of the newer knowledge of nutrition to the improvement of national health and physical fitness is now recognized to be a political problem of the first importance. In the last three years a number of countries have set up National Committees to investigate the food position and advise their respective governments of the measures needed to bring the national dietaries up to the standard required for health. It is already being found that this is not an easy task. The first difficulty is that there are not sufficient protective

foods, e.g. milk, eggs, fruit, and vegetables, in any country, even the wealthiest, to provide a diet on this standard for the whole population. The second difficulty is that, even if the foodstuffs were available, a large proportion of the population could not afford to purchase sufficient, at present prices, to bring their diet up to the standard.

The first of these difficulties can be overcome. Thanks to the advances of agricultural science we can produce in abundance all the foodstuffs which we need. It has been estimated that with the knowledge we now have, it is physically possible for the world to produce sufficient food for twenty times its present population. Nor is there any insuperable physical difficulty with regard to distribution. We can transport food easily and, with modern methods of preservation, we can carry over food from a season of plenty to a season of scarcity with little or no loss of nutritive value.

The second difficulty, that of bringing a diet adequate for health within the purchasing power of the poor, is more formidable. It can be overcome only by adjustments of the economic system or by a great extension of social services. The adjustments needed are difficult to make because they conflict with certain existing economic interests and, what is more important, they are contrary to the ideals we have inherited from the past. In the nineteenth century we were largely dominated by the ideal of commercial prosperity. It was assumed that if trade flourished every one would ultimately benefit. And, indeed, there is a great deal of truth in this assumption, provided no restrictions are placed on production or distribution. But the nineteenth-century economic system of *laisser faire* has broken down and governments have been forced to take measures to control and direct trade and industry and to plan for their future development. These measures, in many cases, involve restrictions on the production and flow of wealth. The fundamental issue at the present time is the objective of government measures. What are we planning for? In democratic countries we are still so obsessed by the idea of the overriding importance of trade as if it were an end in itself that the measures taken so far have been directed mainly to protecting existing trade interests. In the United Kingdom the legislation of the last five or six years, dealing with the produc-

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tion and trade in food, has been directed, not to ensuring that a sufficient amount of food is available to meet national needs for health and physical fitness, but to controlling the supply in the financial interests of existing producers and traders.

Those who have appreciated the importance of the newer knowledge of nutrition for the promotion of human welfare realize that this policy of restriction is bad for public health and bad even for trade itself, for if the national dietary is to be brought up to the standard required for health, there must be a great increase in the production of and trade in the protective foods.

But in a democratic country the government cannot legislate in advance of public opinion. Until a majority of the people see the necessity for making a change, no change is likely to be made. There is always a lag between the acquisition of knowledge and its application to the advance of human welfare. It took two generations for the discoveries of Pasteur to be applied through modern sanitation for the elimination of preventable infectious diseases. But knowledge spreads faster to-day than it did in Pasteur's time. The 'newer knowledge' of the influence of food on health is already widespread and there is a growing demand for the elimination of malnutrition. Both in this and in other countries some of the means which are available are now being used to increase the consumption of protective foods and there is every indication that, in the near future, in dealing with food, the main concern of some governments at least will be the bringing of national dietaries up to the optimum standard.

The most important work which can be done at the present time by those who wish to see the new science of nutrition applied is to spread the knowledge. There is no lack of good-will. So soon as people realize the extent to which ill-health and all the accompanying human misery can be prevented by better feeding, the old idea of the supreme importance of trade as an end in itself will be replaced, at least so far as trade in food is concerned, by the more modern ideal of the promotion of human welfare, and governments will take the necessary steps to ensure that a diet adequate for health is available for the whole community.

The new knowledge is spreading fast in European countries,

in the United States, and in the great British Dominions. A Committee was recently appointed by the British Government to get the knowledge applied for the welfare of the native inhabitants of the British Colonial Empire. In India, the researches of Sir Robert McCarrison gave some indication of the vastness of the problem in that sub-continent and his work is being carried on and extended by his successor, Dr. Aykroyd, and his colleagues at Coonoor and other centres. The movement to get the new science of nutrition applied in practice is thus world-wide.

In no part of the world is the movement more needed than in India, where there are 'only two rice bowls for three mouths'. The fundamental difficulty in India is shortage of food, and from the administrative point of view the problem is one of agricultural reorientation and development to provide more food, especially more milk and other protective foods, for human consumption. This book should prove of value by bringing the facts with regard to nutrition and health in India before those responsible for the government of the country. Professor Gangulee is himself an authority on agriculture and was a member of Lord Linlithgow's Royal Commission on Agriculture in India. He has a first-hand knowledge of the position and those who read this book must be convinced that the most urgent political problem in India at the present time is to devise ways and means of improving the national dietary.

The health and physique of the great bulk of the population in India is far below the average of other civilized countries. If the politicians in India have the welfare of their fellow countrymen at heart, they should sink all political differences and unite in working out and applying a policy which will provide the food needed to enable the people of India to attain their full inherited capacity for physical fitness. Lord Linlithgow, the present Viceroy of India (who was Chairman of the Royal Commission on Agriculture in India) has given an excellent lead to all classes in India in a speech at Simla inaugurating a scheme for providing milk for children. That expression of the new ideal of the Government, referred to on page 217, is well worth re-quoting here in part: 'What indeed, is the use of spending public funds on objects such as education, welfare schemes and the like if the people have not the health

and vigour of mind and body to take full advantage of them and to enjoy them? What indeed can we hope from a political constitution unless we apply ourselves without delay and with persistence, vision, and courage to the improvement of the physical constitution of the common run of man and woman?'

Professor Gangulee's book deals specifically with India but the world has become so small and all countries so closely connected in trade and commerce that India's problem is really part of the world problem. Unfortunately, there is no world-wide government and co-ordinating authority which can adjust the world's food supply to the needs of all the different countries in the world. But we have a British commonwealth of nations and India's food problem is an important aspect of the food problem of the British Empire. We hear of a glut of butter in New Zealand and Australia. In India there are thousands of people going blind every year because of a deficiency of the vitamins found in butter. If we are a commonwealth of nations and if governments exist for the welfare of the people, surely it should not be beyond the wisdom of the governments to prevent the misery of blindness and other associated disabilities by using the surplus in one part of the commonwealth to remove the scarcity which causes these deplorable conditions in another part.

In a speech at Geneva two years ago, the Rt. Hon. Stanley Bruce, High Commissioner for Australia, advocated an agricultural and trade policy based on the needs of the people and coined the much-quoted phrase, 'The marriage of health and agriculture.' If government measures affecting production and distribution of foods were designed to bring the diets of all people within the British Empire up to the standard now known to be necessary for health, there would soon be a great improvement in health and physical fitness. The production and distribution of the additional foodstuffs needed would involve an expansion of agriculture and inter-imperial trade. If governments would put first things first and have for their *supreme overriding objective* in planning for the future, the health, happiness, and welfare of the people, they would have another era of prosperity and expansion in trade and industry and a stable economic and social system based on justice and goodwill between man and man.

FOREWORD

The British Empire needs more statesmen like Lord Linlithgow and Mr. Bruce, men with vision and a wide economic outlook, to guide us by wise measures towards the new era of plenty in which undernourishment and malnutrition, with all the suffering and loss of life these involve, will be no more, and in which man will be able to develop his full inherited capacity for physical and mental health, for happiness to himself, and for service to his fellow men.

Professor Gangulee's account of the food shortage and of the other conditions associated with poverty which cause so much misery and loss of life in India, and his constructive suggestions for remedying these, especially for the improvement of the Indian diet, are valuable contributions to the information which our statesmen used as a guide to the planning for a better future. It is to be hoped that this book will be read by those responsible for the administration of the country, and, indeed, by all interested in the future of India.

Preface

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If any explanation were required of me for venturing to write upon a subject which includes the special preserves of the students of medicine and public health, it might be found, firstly, in the fact that the problems of human nutrition embrace agriculture and animal husbandry, in the study of which I have spent a greater part of my life. Secondly, the science of animal nutrition was one of the major subjects of my studies in the University of Illinois (U.S.A.). I was able, as a student, to follow closely the experiments conducted in the University of Wisconsin in 1907–11. The impetus to such studies came from the assurance given to some of us, then being trained in agricultural colleges of the United States of America, that on our return to India facilities would be available for the establishment of dairy industries in Bengal. Although the proposal for organizing a dairy farm on a large scale did not proceed any further than the expression of good intentions from those who had the necessary resources, my interest in the cultivation of fodder crops and in the problems associated with animal nutrition remained unabated.

During the tenure of my service in the University of Calcutta I undertook to survey the food resources of Bengal in relation to both animal and human nutrition; but owing to lack of proper facilities, this work could not be completed. In 1926–8, as a member of the Royal Commission on Agriculture in India, I became closely acquainted with the pioneer work of Lieut.-Colonel (now Sir) Robert McCarrison and his colleagues. Since then I have pursued the study of the problem of human nutrition in India in its scientific, economic, social, and medical aspects.

In 1935 when the League of Nations set up a committee to

investigate into the state of nutrition of all countries in Europe, it occurred to me that a compilation presenting the subject from a comprehensive point of view might be helpful to those who are now assuming responsibility for the betterment of the public health, nutrition and general economic conditions of my country. I felt that one of the effective means of awakening public opinion in India was to present scientific facts regarding health and nutrition in correlation to the prevailing economic conditions and social backwardness of the Indian masses. In this volume the emphasis is therefore laid upon those aspects of our socio-economic life which are most germane to an understanding of the problem. If I have attempted too much in the way of scientific detail or if discussions appear rather prolix, my excuse is that in undertaking the task involved in the application of the knowledge of nutritional research to communities, leaders of Indian public life should be in possession of all relevant facts which are of the utmost significance for the maintenance and development of health. I crave their indulgence in asking them to go through these pages; for here I present a case for immediate *action*. If this book be of any assistance to them in understanding the ravages of disease and devitalization which are rapidly reducing the great bulk of our population to C3 category, I shall feel that my labour has not been in vain. To the members of the medical profession I would submit, as a justification of my excursion into their problems, that in exploring a promising path of investigation into health and nutrition, their special knowledge has to be integrated and correlated with the entire field of social phenomena. A clear understanding of social pathology is no less important than pure aetiological problems.

Finally I invite constructive criticism and comment from my readers that may be likely to improve the efficiency or usefulness of this book.

I owe a great debt to Sir John Orr, F.R.S., Director of the Rowett Institute, for writing a foreword to the book. My thanks are due to Dr. Et. Burnet, Director, the Pasteur Institute at Tunis, Dr. W. R. Aykroyd, M.D., Director of Nutrition Research, India, Sir John Russell, F.R.S., Director of Rothamsted Experimental Station, Sir John Megaw, I.M.S., and Mr. F. Le Gros Clark, B.A., Secretary to the Committee against Malnutrition,

for their encouragement and support, and to Sir Robert McCarrison, M.D., for his constructive criticism. I am indebted to Mr. Hilary Sumner-Boyd, M.A., for assisting me in research and for revising the manuscript for the press. Acknowledgement is also due to various scientific reports and journals referred to in this book, especially to those who have lent me photographs, charts, and graphs.

N. GANGULEE

London 1938

CHAPTER ONE

The Problem



The emergence of the question of underfeeding and malnutrition as an issue of international importance is a significant recent event. The advance in our knowledge of nutrition and of the consequences of dietetic deficiency upon the health of the community has added a new sharpness to the problem of social injustice which tolerates a wide disparity in the standard of living among the different classes of society. On the one hand we have become to-day 'nutrition conscious', that is, we have realized that the problem of adequate and rational feeding is not the simple matter of consuming enough food which it was thought to be hardly a generation ago, but, on the contrary, that it is a science with laws of its own and problems which are still unsolved. On the other hand, it has become increasingly clear that the problem of nutrition is not isolated, and that scientific research alone cannot provide an adequate solution. The problem is bound up with the whole economic organization of society which, notwithstanding the great advances in science and technology, has failed to relieve the world from the underfeeding of a large proportion of the population. Thus there are two sides to the problem; the scientific side which enquires what are the laws and standards of rational diet; and the broader social side which must attempt to answer the question, how can the optimum diet indicated by the science of nutrition be ensured to the community as a whole. Only when an answer is provided to both these questions can we consider the problem of nutrition solved.

semi-chronic state of depression in agriculture, for the advances in scientific methods of farming had increased output but had reduced prices to such an extent that agricultural production was no longer profitable. On the side of distribution there was a chaotic reduplication of services on a small scale which added out of all proportion to the cost of food products to the retail consumer. Finally, owing to the low income of the mass of the population combined with the relatively high cost of foodstuffs, there was a continuous tendency to under-consumption.

The state was no longer able to remain completely passive in the face of such a situation. If no other motives had forced it to act, it was at least compelled to take notice of the rising spirit of revolt and the growth of strong popular movements which demanded measures for ensuring a healthy life to the workers. The sacrosanct principles of *laisser faire* were first infringed in this sphere by the passage of acts regulating the adulteration of foodstuffs, prohibiting the addition of injurious ingredients, and forbidding the use of lying or misleading descriptions and labels. Later the rudiments of a public health service were established which, among many other duties, had also to deal with the problem of malnutrition, especially among mothers and infants. Finally, in the more advanced countries, a system of school-feeding for malnourished children was introduced. In this way the first tentative steps were taken by the state to tackle the increasingly grave problem of malnutrition.

Such measures on the part of the state gave rise in their turn to a more intensive scientific research into the constituents of diet. The application of the Food Adulteration Acts required a closer study of the chemistry of foods and of the conditions of food preservation, while the activities of the public health service demanded an investigation of the methods of curing and preventing the more pronounced physical effects of malnutrition. Thus, *pari passu* with the deterioration of the food conditions of the people, and especially of the working class, medical and scientific knowledge of nutrition advanced; and it is the glaring contradiction between the norms of science and the actual dietary conditions of the working class which has given rise in recent years to the widespread interest in the problem of nutrition.

II

If, toward the close of the nineteenth and the beginning of the twentieth century, the problem of malnutrition had already taken on national importance, the War of 1914–18 transferred the problem to the international arena. Hitherto the effects of malnutrition had been limited in extent and sporadic in incidence. During the War and the years immediately following, however, the actual problem of the food supply of the civilian population in European countries became acute. The serious scarcity of food necessitated careful rationing. Even in those countries which were least affected by the shortage, alarming symptoms of undernourishment, especially among women and children, became evident. Sheer hunger and despair of finding a solution under the existing economic system led to revolution first in Russia and then in Germany, Austria, and other Central European countries. The failure of the revolutions in Central Europe brought the mass of the working population to the point of actual starvation. Forced by circumstances, the Germans devised new synthetic methods of producing proteinous foods, as, for example, various preparations based on a combination of yeast with other food constituents. But the food scarcity during the War and the blockade, which was maintained by the Allies even after the Armistice, very seriously injured the generation born during the period. The mass of the population had to live on black bread and potatoes, the supply of meat, eggs, milk, and milk products being practically non-existent. Rickets, 'hunger osteomalacia', nutritional oedema, and other acute symptoms of dietary deficiency were widespread. The death rate from tuberculosis increased by 70 per cent, and there were indications of grave deterioration in the physique of the young members of the community. It is estimated that in the countries seriously affected by the War and its aftermath about 60 per cent of the children showed signs of arrested growth, and 40 per cent of tuberculous glands. Such was the state of affairs where actual famine did not exist. But famine itself was widespread in Eastern Europe, and produced a grim spectre of misery reminiscent of Indian famines. One example will suffice to show the horrifying increase of disease which was an indirect result of famine conditions: in south-eastern Russia in 1923 more than thirteen million cases

of malaria were reported as compared with the maximum figure of three and a half million before the War.

To add to the havoc caused by the War, the Armistice was followed by economic and financial reprisals. Instead of accepting Wilson's utopian formula of 'Peace without Victory' the conquerors wanted victory with vengeance. The peace treaties not only failed to make provision for supplying the minimum essentials of life to the peoples exhausted by war; on the contrary, they were used to intensify the economic conflict which, precisely, had caused the war. Tariffs, embargoes, war debts, financial restrictions, and every weapon that can be forged under the existing economic system simply replaced the machine-guns, tanks, artillery, and gas of the preceding years. It has been truly said that 'the supreme illusion of the post-war world lies precisely in the assumption that armed conflict alone is war'. Thus the inevitable dislocation of world economy incident to any great war was intensified a hundredfold by the action of the victorious Powers.

From a scientific point of view, the War and post-War periods offered unrivalled opportunities to observe and study the effects of malnutrition. In the clinics of starving Vienna immense progress was made in the diagnosis of undernourishment and its attendant diseases. It was during this period that the scales and standards for assessing the existence and extent of malnutrition were greatly improved. Of wider scope, investigations were carried out into the relation between the food supply and the actual conditions of nutrition prevailing in countries both more and less affected by the economic débâcle.

The period of acute distress was followed by a few years of relative stability, and the illusion that conditions had returned to normal was sedulously fostered by interested parties. In 1929, however, a crisis of unprecedented dimensions occurred; debts mounted up, channels of trade and commerce became dislocated or choked, and industrial nations found themselves unable to buy from each other their essential requirements. Excessive production and diminished consumption were at once the cause and the paradox of the world depression—the paradox inherent in the crises of capitalism. Particularly important from the point of view of the food supply of the masses was the tendency already noted in the nineteenth century

toward disequilibrium between agricultural and industrial production which gave rise to a semi-chronic state of depression in agriculture. The world depression very greatly aggravated this tendency, and the languishing state of agriculture changed suddenly into acute crisis. Hence the paradoxical situation of malnutrition and undernourishment in the midst of plenty.

In these conditions, governments were forced to sacrifice what still remained after the War of the principles of *laisser-faire*, and their first efforts were directed at doing so without restricting the profits of the big farmers and industrialists. Some of the food-producing countries adopted measures for *the restriction of agricultural production, others for the actual* destruction of foodstuffs. Thus was it hoped to save the farmer at the expense of the community, and to cure the disease of 'poverty in the midst of plenty by eliminating the plenty *instead of the poverty'. It will be interesting to mention here* a few examples of these expedients to show to what incredible lengths this suicidal policy was taken. Owing to the restrictions imposed on the export of meat by the Ottawa Agreement in 1932, the Government of Chile considered it expedient to kill 500,000 sheep for the manufacture of tallow on condition that the carcases should be burnt. In Denmark the Government created a special destruction fund to kill and burn about 5,000 cattle per week. The Spanish Government thought it necessary to dump into the sea thousands of cases of oranges and many tons of vegetables. In America, the farmers of Kansas and Nebraska were subsidized for burning their grain; ten million acres of cotton and some thousands of tobacco were ploughed under, on the ground that these harvests would further have depressed the world market. For the sake of 'national prosperity' the Federal Government ordered the slaughter of some five million pigs and some 200,000 prospective mother sows. Brazil burnt its coffee crop; herrings were dumped into the sea in English ports. These examples could be greatly multiplied. Yet, at the beginning of 1932, in the midst of this period of feverish destruction of food, it is estimated that there were more than 25,000,000 unemployed in Europe and America, and the majority of these were suffering from all degrees of undernourishment and malnutrition. The *absurdity, not to*

speak of the iniquity, of an economic system which permitted such a state of affairs began to make itself felt, and governments were gradually forced to abandon the more extreme excesses to which their desire to maintain the system of private profit had led them.

Weary of the orgies of destruction, the governments attempted to find some more rational solution of the problem. In some cases instead of destroying the 'surplus' of production it was bought by the State and distributed as relief to the unemployed. But it had become clear that the problem was no longer national and that the isolated efforts of a single country, whether to destroy its wealth or to husband it, would ultimately prove ineffective. Only international co-operation could, under the favourable circumstances of economic recovery, provide a solution. The question was taken up by the League of Nations.

In September 1935 the Assembly of the League had a long discussion of the problem of defective nutrition and of 'the effects of improved nutrition on the consumption of agricultural products'. General recommendations were made on the subject of the removal of tariff barriers and other impediments to international trade and on the necessity of ensuring a larger purchasing power to the general consumer. The Health Organization was instructed to include the study of nutrition in its regular programme of research. And finally a Special Committee was set up to investigate the problem of nutrition both in its scientific and its social and economic aspects. The preliminary investigations carried out by this Special Committee have emphasized the fact that the problem of nutrition is not merely a scientific problem, but that its solution lies in formulating the social and economic policies of each nation with due regard to the health and normal development of the population. Whether this recommendation can be realized in an economic system where organized planning is impossible is a question open to doubt.

Recapitulating the argument thus far, we may say: the problem of nutrition was posed in the first instance by the contradictions inherent in the capitalist mode of production. Step by step with the appearance of the symptoms of undernourishment, the science of nutrition advanced and provided the

medical and technical basis for a solution of the problem. The deeper economic causes, however, remained. The Great War and the recent world depression brought the question into sharp relief and thrust it upon the notice of public opinion as a whole. The definitive solution of the problem is one of the vital tasks of the day.

III

If, in the advanced industrial countries, the consequences of dietary deficiency have become alarming, it may easily be imagined what serious proportions they assume in countries of a low economic development. India with her widespread poverty is such a country. The world depression has created in the advanced countries of the West a class of 'new poor'; but in India we have to face the problem of the *chronic* poor with all the distressing symptoms resulting from continuous undernourishment and malnutrition. And where poverty, serious maladjustments in economic life, age-worn social customs and ignorance coincide, these problems assume a character altogether different in proportion from those that confront Western humanity.

The economic position of India differs profoundly from that of the advanced Western countries. There, the economic system, however great its disequilibrium and contradictions, is at least homogeneous and highly developed. In India, on the other hand, the economic system is a mixture of at least three different and conflicting elements: the decaying feudal substructure, the slowly advancing Indian capitalist organization of industry, and the fully developed foreign imperialism.

India is a predominantly agricultural country. The organization of rural economy is still largely feudal, although the rapid increase of speculative capitalist landowners is beginning to transform the relations of production in the agricultural field as well as in the industrial. Agricultural production is low, not merely because of the primitive methods adopted in cultivation or of limitations imposed by climatic conditions but particularly on account of the circumstances under which the Indian peasant works. The ownership of the land under the existing agrarian system is unequal and unjust, more than five-sevenths of the cultivable land being in the hands of less

speak of the iniquity, of an economic system which permitted such a state of affairs began to make itself felt, and governments were gradually forced to abandon the more extreme excesses to which their desire to maintain the system of private profit had led them.

Weary of the orgies of destruction, the governments attempted to find some more rational solution of the problem. In some cases instead of destroying the 'surplus' of production it was bought by the State and distributed as relief to the unemployed. But it had become clear that the problem was no longer national and that the isolated efforts of a single country, whether to destroy its wealth or to husband it, would ultimately prove ineffective. Only international co-operation could, under the favourable circumstances of economic recovery, provide a solution. The question was taken up by the League of Nations.

In September 1935 the Assembly of the League had a long discussion of the problem of defective nutrition and of 'the effects of improved nutrition on the consumption of agricultural products'. General recommendations were made on the subject of the removal of tariff barriers and other impediments to international trade and on the necessity of ensuring a larger purchasing power to the general consumer. The Health Organization was instructed to include the study of nutrition in its regular programme of research. And finally a Special Committee was set up to investigate the problem of nutrition both in its scientific and its social and economic aspects. The preliminary investigations carried out by this Special Committee have emphasized the fact that the problem of nutrition is not merely a scientific problem, but that its solution lies in formulating the social and economic policies of each nation with due regard to the health and normal development of the population. Whether this recommendation can be realized in an economic system where organized planning is impossible is a question open to doubt.

Recapitulating the argument thus far, we may say: the problem of nutrition was posed in the first instance by the contradictions inherent in the capitalist mode of production. Step by step with the appearance of the symptoms of undernourishment, the science of nutrition advanced and provided the

to some extent approximates to conditions in the West during the early stages of the industrial revolution, is exacerbated by the third distinctive feature of Indian economy, the domination of British imperialism. From the point of view of the metropolis, the fundamental purpose of a colonial empire is to supply a source of raw materials as well as to provide a market for manufactured goods. It is not therefore to the advantage of the imperialist country to foster the growth of either agriculture or industry in the countries under its control deliberately for the benefit of the indigenous peoples. For if agricultural production exceeds that which is required by the metropolis, so that the surplus can be exported to other countries, the former will lose its privileged position as owner of cheap raw materials. On the other hand, if there is a large development of indigenous industries, the colonial market for the manufactured products of the mother country will contract.

Thus British Imperialism seeks to keep the population on the land. In 1880 the Famine Commission observed that 'the numbers who have no other employment than agriculture are greatly in excess of what is really required for the thorough cultivation of the land'. But this tendency has been increasing since that date. The census figures for the proportion of the population supported by agriculture are instructive: from 61 per cent in 1891, the figure rose to 71·6 per cent in 1921 and 73·9 per cent in 1931. The vast irrigation works in the Punjab, the United Provinces and Sind, involving the investment of over £100 millions which, at an average interest of 7·3 per cent, implies the financial enslavement of India to Britain in perpetuity, while they open up many millions of acres to agriculture, do not advance by one step the really vital problems of the redistribution of the land and the introduction of modern methods of cultivation.

Irrigation under feudal economy cannot benefit the actual cultivator. Even in the Punjab the proportion of the landlords' share to total income shows that the cultivator receives less than 18 per cent as against 82·4 per cent enjoyed by the landlord. As regards the progress of agriculture, only a small proportion of the land is now cropped with improved varieties. Agricultural research has chiefly been directed to crops of commercial value and little has so far been done for the better

than one-third of the landowners, who take full advantage of the financial embarrassment of the cultivator and gradually reduce him to a position where, to quote the Royal Commission on Indian Agriculture (1928), 'for land he must plead *before a creditor to whom he probably already owes more than* the total value of the whole of his assets'. For his bare subsistence, he has thus to depend on the mercy of landlords and usurers.

According to conservative official estimates, a holding of about fifteen acres is required to yield an income sufficient to supply the necessities of life; yet more than three-fourths of the holdings are less, and for the most part considerably less, than this size, the *average* holding being only five acres. Moreover, the holdings of the smallest size (below one and a half acres) are increasing out of all proportion to the larger and more adequate holdings.

The productivity of the soil shows a steady decline throughout India; the tracts renowned for their natural fertility (e.g. the Gangetic Valley) have themselves reached a 'dead level'. Even for the irrigated areas in the Punjab, Darling estimates that eight or ten acres 'are wholly insufficient, under present conditions, to maintain him (the cultivator) in decency, independence, and comfort'.

The disintegration of the old agricultural system is not compensated, as it was in the West, by a very rapid expansion in industry. On the contrary, the growth of Indian industry, *though appreciable, is slow compared with the decline in* agriculture. The superfluous agricultural population, even if it were in a position to emigrate to the towns, is not readily absorbed in the industrial enterprises. The conditions of industrial employment, moreover, are such as have disappeared from the advanced Western countries many decades ago: incredibly low wages, excessively long hours, and wretched working conditions. The productivity of Indian labour is extremely low, partly because of the vast surplus population which floods the labour market and makes it cheaper for the manufacturers to employ human labour than machines, partly because of the crude methods which are still prevalent in the mining and other organized industries.

This lamentable situation in agriculture and industry, which

be denied that the standard of the adjustment falls far short of any reasonable efficiency. After all, the mere survival of a community is not an indication of the adequacy of its food supply, and health is something more than mere survival. 'It is often forgotten', observes Sir Frederick G. Hopkins, 'that such environment is fortuitous, and that the equilibrium reached is one in which the community, while managing to survive, may yet be functioning at levels far below those possible to its innate capacities.'

In some responsible quarters in India it is believed that the 'question of nutrition is primarily the problem of the urban population on whom the pressure of all the complicated factors of the civilization impinges'.* But it is sheer delusion to imagine that the conditions of life and labour in our rural areas can 'keep the peasantry healthy and robust', and that our rural population 'eat well and sleep well'. The idea that in their simple dietaries the villagers provide themselves with adequate nourishment is a myth.

Even a casual visitor to India cannot fail to observe the poor physique, under-developed muscles, stunted growth, and anaemic condition of the bulk of her population. The majority of the labouring class is starved, nervous, weakly, and morose; derelicts, semi-derelicts, youths with the premature appearance of old age crowd the industrial centres and mining areas of India. If one cares to investigate further, it becomes evident that the Indian masses have low powers of endurance, that they are very susceptible to infectious diseases and that their pessimistic outlook on life may even be due to their being habitually undernourished or malnourished.

There is no proper survey of the composition of the dietaries of the different races and communities in India; nor are we in possession of sufficient data to estimate the degree of malnutrition or chronic undernourishment of the peoples. But there is an abundance of evidence that the ill-health from which they suffer is largely due to defective diet. 'It must be realized', writes Sir Robert McCarrison, 'that normal nutrition and health cannot be maintained on many of the diets now used by millions of the people of India.' Facts are being brought to our knowledge which show that many of the diseases

* *Current Science*, India, 1936.

cultivation of essential food crops such as rice, millet, fruits and vegetables, and for the development of dairying. Agriculture in India is thus essentially dominated by the motive of producing cheap raw produce for the benefit of British commerce and the Indian bourgeoisie.

If the natural process of development from feudalism to capitalism in the West produced serious nutritional problems, it is clear that in India, where the transition from one economic system to another is complicated and made more difficult by imperialist domination, similar but more acute problems must result. Here the alliance of foreign imperialism with the propertied classes, the establishment of complicated legal systems for the protection of their rights, the maintenance of an agrarian system based largely on the renting of land, the consequent separation of landownership from cultivation, the drastic transformation of the village community through a centralized and rigid administration, the policy of that administration to lend support to a structure of rural economy which functions to the disadvantage of the tillers of the soil, and, in fact, the whole trend of development in the nineteenth century favoured the growth of a complex variety of factors which created disharmonies and intensified antagonisms between all classes and between various religio-social groups.

But things cannot go on indefinitely in such a state of anarchy. No matter where one looks in India one sees chronic starvation, ill-health, and premature death. And if a very large proportion of her peoples are beset with poverty of a kind which finds no parallel in a civilized country, there can be no security, no stability, and no peaceful adjustments in social relations.

It is often argued that in the various Indian communities there exists a sort of adjustment with the environment, and that the food supply is both qualitatively and quantitatively regulated in accordance with the needs of the peoples. In reality there is every reason to believe that this is not the case. The results of a number of local surveys of dietaries show that the Indian communities have not been able to adjust their food requirements to the circumstances of their life and labour. Even if we admit the existence of some sort of equilibrium with the environmental factors which include food supply, it cannot

be denied that the standard of the adjustment falls far short of any reasonable efficiency. After all, the mere survival of a community is not an indication of the adequacy of its food supply, and health is something more than mere survival. 'It is often forgotten', observes Sir Frederick G. Hopkins, 'that such environment is fortuitous, and that the equilibrium reached is one in which the community, while managing to survive, may yet be functioning at levels far below those possible to its innate capacities.'

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* *Current Science*, India, 1936.

in India are due to nutritional maladjustments. Even when the diets used by various communities in India are barely sufficient in quantity, they are markedly deficient in quality. If inadequate in quantity, the lower food intake results in undernourishment; if deficient in some essential constituents, the diet is not protective, and leads to ill-health and disease. Or again, if the necessary constituents are present but not in the right proportions, the diet is not balanced and the symptoms of malnutrition become manifest. The effects of such a state of imperfect nutrition may not be evident at the outset in the form of definite diseases, and they may not be reflected in the vital statistics of the country. Nevertheless, a widespread condition of health may prevail which can be described as the 'threshold state'. It is in this state of health that the bulk of the Indian people ekes out its existence. With the advent of an epidemic or an economic crisis the existence of this borderline of actual malnutrition reveals itself not only in the high death rate, but in greatly increased morbidity among the masses.

IV

In the preparation of the present volume two definite objectives have been sought; first, to place before Indian students a general summary of the findings of nutritional research; secondly, to invite Indian public opinion to consider the problem of nutrition as a whole in all its implications. The difficulties inherent in a proper solution of the problem are many, but in India they are rendered extremely complex by being interwoven with the texture and custom of varied social structures. Indeed the roots of poverty are so welded with some of our social customs, that sometimes it is difficult to discriminate one from the other. The progress in the application of nutritional science to dietary habits must depend not only upon the raising of the standard of living but also upon the social evolution of the peoples of India. The broader understanding of the food requirements of the country and the formulation of its economic policy in relation to those needs should result in accelerating the process of that evolution.

In 1876 Carl Voidt, to whose contributions to the science of nutrition we refer in tracing the history of its development, observed in a moment of despair that 'the proper nutrition of

man concerns no one, not even those classes which should take the subject most to heart, and it is rare to find any one who has a proper understanding of the subject. This shortsighted attitude is due to the fact that such knowledge cannot be expressed in terms of money. It is analogous to the shortsightedness of the peasant who gives more attention to the nutrition of his cattle, whose meat and milk he sells, than he does to that of his children.' Since his time, however, there has been no abatement in the enthusiasm for research on animal nutrition and both the State and public opinion in advanced countries have been making efforts to improve human nutrition.

In India nutritional research and education have only recently received some attention from the Government; but under the special circumstances of the country, there can be no positive advance in these directions unless an alert public opinion becomes fully aware of the dire consequences of leaving the great bulk of the population to such a lamentable condition. In India we are faced not only with the inertia of the masses but also with the apathy of the educated communities. With the introductions of the new Governments—Federal and Provincial—there have been definite changes in the administrative systems of Public Health, agriculture, animal husbandry, and other allied subjects with which the problem of nutrition is interrelated. The direction of these subjects has passed into the hands of Indians, and it is now time for them to face the problem with courage and circumspection and without ambiguity. They should bear in mind that the balance sheet of social economy in India shows a state of bankruptcy and that it cannot be settled by any compromise with a medieval social system or with the combined forces of imperialism and complicated forms of landlordism to which we have already referred. Our foremost need is to bring about a new orientation in agriculture—the only source of human nutrition. Time and again, our attention has been drawn to the problem which is presented in this volume; but as we have not overcome the influence of those inhibitory factors which breed apathy and conservatism, no solution of any consequence has been arrived at. The decentralized scheme of administration under the new Constitution should not be allowed to interfere with the policy of considering the food economy of the country as a whole; for

any policy designed to achieve substantial progress in nutrition and health can only be effective if it embraces within its scope all essential aspects of the economic and social problem.

V

It is not possible to discuss intelligently the problem of health and nutrition without a basic knowledge of certain fundamental principles upon which the science of nutrition is based. Therefore in Chapters Two and Three I have attempted to set out in non-technical language the broad scientific aspects of the problem.

The fourth chapter of the book contains a brief account of the prevailing conditions of public health in India with special reference to our main theme. This is followed by a survey of Indian foodstuffs. Data regarding the caloric and biological values, vitamin content, and inorganic constituents are being accumulated by the Nutrition Research Laboratories at Coonoor and the All-India Institute of Hygiene and Public Health in Calcutta. I have used these data whenever possible in order to impress upon the educated Indian public that researches of this character are not of academic interest only but offer us a reliable guide to our dietetic requirements. In writing this book I aimed at providing the reader with an adequate knowledge of the essential facts of nutrition and of the nutritive values of various foodstuffs so that he may apprehend their importance in adjusting his own as well as the nation's dietaries to the best advantage.

A chapter is devoted to describing the salient features of the diets of different Indian communities; but, owing to the inadequate data available at the moment, it has not been possible to show the relationship between their diets and incomes. I have, however, endeavoured to analyse a number of family budgets of our industrial workers in order to emphasize the fact that the problems of nutrition cannot be divorced from economic realities. It is greatly to be hoped that investigations on a broad scale by appropriate organizations will be made throughout India to correlate the state of nutrition of the people with their incomes. Such a survey would reveal not only the extent of the inadequacy of diet but also the varied aspects of the problem of nutrition.

For the guidance of my countrymen who are now at the helm of the Provincial Governments I have given a brief résumé of what is being done in certain advanced countries, within the limits set by political, social, and economic conditions, for raising the standard of health through improved nutrition. Although India can draw upon the accumulated experience of these countries, there are obviously many special problems which have to be investigated under different and varying conditions. It will, however, be seen that scientific investigation and the development of institutional feeding, important as they are, can but touch the fringe of the problem, and that its real solution depends upon far-reaching changes in the forms of production, distribution, and consumption. Even in the advanced countries of the West, it is being realized that the *problem of malnutrition and undernourishment is not entirely* or even largely a medical one and that its solution rests with the capacity of nations to revalue and adapt their economic and social structures in conformity with the circumstances of modern life. The education of the people in the principles of nutrition is, of course, helpful; but the capacity of choosing food to the best physiological advantage is not enough. The people must have the means of providing themselves with adequate and proper diet, and should be given the opportunity of purchasing it in the cheapest markets.

In the concluding chapter I have indicated how a substantial advance may be made in India towards the solution of her nutritional problems. Here the factual knowledge in regard to nutrition, health, and income is incomplete. But the prevalence of widespread malnutrition and undernourishment among our peoples cannot escape a discerning eye, and the economic and social conditions under which the vast majority are now suffering must remain a challenge to Indian statesmanship. While it is difficult to lay down precise methods of approach to the problems of health, physique, and nutrition of all the Indian communities and classes, some of the essential steps towards the solution of widespread malnutrition may be indicated. This I have attempted to do.

Our agricultural industry must be made alive to the urgent need of adjustment to the optimum nutritional requirements of the people. We have not only to find enough food but also

this harmony difficult to attain. As Dr. E. P. Cathcart observed, malnutrition of the spirit is as prevalent as malnutrition of the body and the one reacts upon the other. Since the momentum of our national movement must come from the realm of the spirit, there is no problem more urgent than that of health and nutrition in India.

CHAPTER TWO

The Science of Nutrition

*

The History and Theory of Nutrition

Nutrition is defined as 'the sum of the processes by which an organism is nourished by absorbing substances different from itself and assimilating them to substances identical with itself'. We should lay stress upon the word 'sum', because the consumption of food is not identical with nutrition. It involves a series of co-ordinated processes, such as mastication, digestion, absorption, assimilation, excretion, and so on. The function of the digestive system, for example, is to render food soluble, diffusible, absorbable, and finally assimilable so that the body may pick out those constituents it needs for reconstruction and for fuel, and reject those materials which are useless. The body functions through the energy released by the different food constituents, and nutrition is nothing but energy exchange through which the mechanism of the body and of its constituent parts is kept in proper running order. Food, as McCarrison puts it, 'is the instrument of nourishment; nutrition is the act of using it'. Nutrition is indeed synonymous with existence; or, as Claud Bernard (1867) defined it, 'perpetual creation'.

The science of nutrition is one of the youngest of the sciences. A hundred years ago practically nothing was known with scientific accuracy about either the composition of the various foodstuffs or the precise function which food plays in the maintenance of the human organism.

It is true that from time immemorial there have been theories about diet, and certain foods have been prohibited as injurious or prescribed as health giving. Many of these taboos

or recommendations, such as the prohibition of pork among the Jews or of beef among the Hindus, are of a primarily religious character and make no pretence to scientific principle. Pythagoras, on the other hand, with a parade of science, alleged that it was deleterious to eat beans; while the German philosopher, Feuerbach, ascribed most of the evils of civilization to the fact that not enough beans were consumed. In his book, *Castel of Helth* (1534), Sir Thomas Elyot recorded a few examples of what food it was advised to avoid in the Middle Ages. 'Bean skins cause constipation, dry the phlegm, injure the stomach and eyes'; '*Figs breed lice and stir up lust*'; *cheese by the* whole sentence of all ancient writers 'letteth [hinders] digestion and is enemy to the stomach; also it engendereth ill humour and breedeth the stone.'

In 1599, an Oxford physician, Henry Buttes, published a treatise containing a number of cookery recipes and gave solemn advice as to the dietary value of foodstuffs. To him carrots were 'of small nourishment, slowly digested', but radish 'causeth leannesse, belchings, headache and lice'. Spinach would 'cure the cough, make the belly soluble . . .'. He warned us about pork, which caused 'the gowte and sciatica', but the meat of hare had a special virtue of 'procuring beautie, fresh colour and cheerfull countenance'.

From that treasury of ancient and medieval lore, Burton's *Anatomy of Melancholy*, we may learn all that was known of nutrition up to the seventeenth century. Burton does indeed ascribe great weight to diet as a cause of 'melancholy', and quotes no less than twenty-seven authorities, ancient and modern, on the subject. But a glance at some of his remarks on individual foods will show his approach to the problem: 'Milk, and all that comes of milk, as butter and cheese, curds, etc., increase melancholy (whey only excepted, which is most wholesome); some except asses' milk.' 'Among herbs to be eaten I find gourds, cowcumbers, coleworts, melons disallowed, but especially cabbage. It causeth troublesome dreams, and sendeth up black vapours to the brain.' Even our modern diet faddists would hardly go so far as this! Fortunately there is no reason to believe that anybody followed the advice of Burton and his authorities; but it is interesting as showing what a depth of ignorance of the very rudiments of nutrition existed even

among the learned at that time. There was as yet, in nutrition as in the other sciences, no thought of empirical investigation, of making experiments with foods and actually observing their effects.

But Burton was a contemporary of Bacon, and with Bacon the method of modern experimental science began. The seventeenth century, the 'Century of Genius', as Professor Whitehead calls it, saw the rebirth and the triumphant progress not only of the mathematical sciences but also of physics, astronomy and preventive medicine. The scientific spirit which then arose has continued to our own day and is continually making fresh contributions to the sum of human knowledge.

Here at the very beginning of our study of nutritional science, however, a warning must be given against hasty and unscientific conclusions. This is especially necessary since diet is a happy hunting ground for quacks and faddists, and is easily exploited in advertisements by manufacturers of patent food preparations. The scientific knowledge of nutrition which we possess to-day, though in many respects incomplete and even fragmentary, is quite sufficient to prevent us from jumping to unwarrantable and unsound conclusions; and indeed its very incompleteness should put us on our guard against the grandiloquent claims that are made by the faddists for their particular brand of diet. It is possible to lay down certain broad scientific principles of diet with precision and certainty; it is not yet possible to enter into the minutiae of diet, prohibiting this, that or the other particular foodstuff, except in the case of certain definite and limited therapeutic dietaries. Any suggested diet which banishes some well-known and universally consumed foodstuff from the table, or segregates the types of foodstuffs and insists on their being consumed separately, while it *may* embody some dietary principles that will sometime be shown to be correct, is based, so far as our present knowledge goes, on no scientific evidence whatsoever.

It is the purpose of this chapter to set out those principles of nutrition that are known with certainty and based on trustworthy and tested evidence, showing in brief how the science has developed from its first beginnings in the eighteenth century, and indicating where clear knowledge is still lacking and where further research is needed.

Curiously enough the first scientific approach to the study of nutrition was made not through medicine, as one might have expected, but through chemistry. Already in the eighteenth century Lavoisier (1743–94) showed that when an organic substance burned, the products of combustion were equal to the sum of the original substance plus oxygen, and discovered that the process of heat production in man was related to that of oxidation. That is, the oxidation or combustion of food in the cells was similar to the combustion of coal or wood to furnish heat. Oxygen is furnished by the lungs, and carried by the blood to all the cells of the body. From the process of combustion which takes place inside the body there results the production of animal heat.*

It was not till more than half a century later that this important discovery was put to practical use. By about the middle of the nineteenth century the principle of the Conservation of Energy had been definitely established; and in 1850 the English physicist Joule (1818–89) proved that heat and energy were interchangeable entities and that one could be measured in terms of the other. The establishment of this principle made possible the researches of Pettenkoffer and Voit (1871) into the energy output of living beings. Their experiments resulted in the exact correlation of the energy output of an organism with the energy supplied to it in food.

They devised a method of measuring the precise amount of energy (or heat) given off by a living body under various conditions. Every one knows how when several people are sitting in a closed room the air becomes gradually warmer and the atmosphere grows close and stuffy. This was the very simple principle of Pettenkoffer and Voit's celebrated 'animal calorimeter'. *They placed a man or animal in a carefully constructed* chamber whose temperature could be kept perfectly

* Commenting upon his discoveries Lavoisier wrote during the hard time of the French Revolution: 'Does it not seem a great injustice of Nature that the poor labourer uses more of his body substance, while superfluity, which is unnecessary for the rich, should be his portion?' He [illegible]

nutrition.

even and which was supplied with instruments for measuring on the one hand any rise in temperature owing to the presence of a body in the chamber—that is, the body's loss of heat—and, on the other hand, the exact volume of oxygen taken in and of carbon dioxide given off—that is, the amount of combustion that had taken place. From these measurements it was possible to calculate exactly the amount of energy used up in the processes of life.

Basal Metabolism

The energy was measured in 'calories',* or units of heat; and it was shown that a man at rest expends approximately (food equivalent to) 1,800 calories a day to keep his heart beating and his respiratory muscles moving. This is called 'basal metabolism', that is, the amount of energy required simply to *live*, at rest in a warm atmosphere. In other words, the minimum demand for energy is the amount which is required for basal metabolism. Since the problem of estimating a diet in relation to its energy value is dependent upon accurate information about the basal metabolism, we shall consider it in further detail.

It represents 'the irreducible minimum' of the body's demand for energy. Consequently the need for the energy represented in functional activities has to be superimposed upon the basal metabolic rate. Benedict points out[1] that the basal metabolism of an individual is a function of the total mass of active protoplasmic tissue, and second, of the stimulus to cellular activity existing at the time the measurement of the metabolism was made. The technique employed in determining the rate of metabolism in a subject is by the measurement of 'the quantity of energy expended per hour and per square metre of the surface of the body of a subject completely at rest and having fasted from 12 to 14 hours at 16 degrees C. and sufficiently clothed to prevent reaction to external cold.'

The basal metabolism is dependent upon several variable factors such as body-weight, age, sex, habits, profession, and racial characteristics. But the variations influenced by weight

* A calorie equals the amount of heat required to raise a litre of water one degree centigrade; or a pound of water four degrees F.

and build, or by sex, are negligible. Age is of course an important factor. Whether race *per se* is a factor influencing normal metabolic rate is still an open question. An investigation carried out in the Department of Zoology and Physiology at the Women's Christian College, Madras,[2] on the basal metabolism of South Indian women of ages ranging from 17 to 31 years, shows their basal metabolism is considerably lower than the Western standards. The authors suggest that while this difference indicates the influence of the racial factor, it may also be related to a low protein metabolism so characteristic among South Indian women.

According to other investigations, there is no essential difference in the basal metabolism in people whether living in the tropics or in the temperate zones; nor is there a wide disparity in its rate between vegetarian and non-vegetarian. It is of course influenced by certain pathological conditions. Prolonged semi-starvation reduces and food intake raises the metabolic rate.

The energy requirements of the body have been the subject of extensive investigation and it is found that they vary according to the size of the individual, the temperature of the environment and the amount of work he is doing, etc. Any increase of physical exertion therefore leads to an increased expenditure of calories. It has been estimated, for example, that an average man doing sedentary work expends about 2,500 calories a day; while an active manual worker, e.g. a farmer, expends 3,500.[3]

Now since, according to the law of the conservation of energy, energy cannot be newly created by the body, it must be supplied from without; that is, it must be obtained from the food taken in and oxydized or burned inside the body, or, alternatively, from the food stored up in the body in the form of fat. This combustion is the source of the energy which permits the body to carry on its activities. Voit and Pettenkoffer further showed that food burned inside the body produced exactly the same amount of energy as food burned outside it. It is therefore possible to determine the energy value of a foodstuff by burning a known amount of it under definite conditions and noticing the number of calories given off.

When, therefore, the amount of energy daily expended by

persons in various occupations is known, the amount of food required to supply this energy is also known, for both are measured in calories and both are equal. If more food is eaten than is required to produce the amount of energy expended it will be stored up in the body in the form of fat. And, vice versa, if less food is eaten than is required the extra energy will have to be supplied by the use of some of the fat that has already been stored up.

Thus the technique of calorimetry enables us to determine the caloric requirements of individuals and also provides the equivalent caloric value of food substances. It was then held that the science of nutrition had come to a stage where the knowledge in regard to nutritional requirements and diets was complete. Indeed, Rubner, in the last part of the nineteenth century, declared that there was little further to be learnt in the field of nutrition.

The Protein Component

But at the same time that these researches into the energy-producing functions of food in general were being carried out, investigations into the various foodstuffs in particular, their classification and individual functions, were also being made. The first step was again taken by a Frenchman, François Magendie (1783–1855), who showed that foods differ in chemical content. He was able to differentiate between the nutritive values of the three substances—protein or albumins, fats or hydrocarbons, and carbohydrates (starches, sugars, and cellulose) contained in foodstuffs, and made the distinction between the nitrogenous and non-nitrogenous groups clear. His discoveries were carried further by the great German biochemist, Justus von Liebig (1803–73), who proved that carbon and hydrogen, which are the fundamental elements of food, are present in the various foodstuffs in the form of certain definite chemical compounds. These compounds, discovered less than a hundred years ago, are the now universally known substances, protein, carbohydrate, and fat. It is they that form the major nutritive constituents in food, and each must be separately discussed.

The term 'protein' was coined by the Dutch physiological

chemist Mulder (1802–80) from a Greek verb meaning 'to take first place', in order to signify that it was an indispensable constituent of every living cell. His observations upon this nutrient element may be of interest. 'In both plants and animals a substance is contained, which is produced within the former, *and is imparted through their food to the latter. To both, its* uses are numberless. It is one of the most complicated substances, is very changeable in composition under various circumstances, and hence is a source of chemical transformation, especially within the animal body, which cannot even be imagined without it. It is unquestionably the most important of all known substances in the organic kingdom. Without it no life appears possible on our planet. Through its means the chief phenomena of life are produced. . . . This substance has received the name of protein, because it is the origin of so many dissimilar bodies, and is itself therefore a primary substance.'[4]

The chemical structure of proteins, which is very complicated, was independently discovered by Kossel, Hofmeister, and Fischer. The complex protein molecule is built up of a large number of 'amino-acids'.* Thus the proteins found in different foodstuffs differ in chemical structure: that is, they all have different combinations and different amounts of amino-acids. This is a fact of great importance, for some amino-acids are essential nutritive elements, others are valueless. For example: ovitellin, protein of egg yoke, contains 5 per cent of the important amino-acid lysin, which is necessary for growth; while zein, protein of maize, contains none. Some proteins, such as gelatine, for example, are almost completely useless; others such as those of milk, meat, and eggs are *ideal. Thus in arranging diets it is not sufficient to allow* enough protein in general, but care must also be taken that the proteins consumed do in fact contain the essential amino-acids.

The specific function of protein is to build tissue, that is, to create flesh and blood in the growing organism and to make good the continuous destruction of tissue that takes place in the body. Protein alone of all the food substances can build tissue, and it is therefore of extreme importance, especially to

* See Table II, p. 60.

children and persons who have not yet completed their growth. It is not, indeed, protein itself out of which tissues are made, but rather the amino-acids which compose it. When protein enters the body it is split up in the process of digestion into its constituent acids, which are then assimilated with the flesh and blood. Thus it has been well said that 'amino-acids, not proteins, are the bricks out of which the body builds new tissue'. But these acids are not found in carbohydrate, fat, and other food substances, and protein is therefore an essential element in diet.

The body is subjected to a continuous drain of protein. Tissue destruction and the consequent loss of protein go on whatever the diet may be, and it is therefore necessary to consume enough at least to make good this loss. Protein contains about 18 per cent of nitrogen, and the 'protein exchange' of the body is calculated by nitrogen measurements. That is, the rate of tissue destruction can be measured by the amount of nitrogen excreted by the body. In starvation the excretion of nitrogen will be about four to five grains a day, for the body will continue to metabolize protein derived from the breaking down of its own tissue cells. In the case of adequate food intake, on the other hand, a state of 'nitrogenous equilibrium' is attained, in which the output of nitrogen will exactly balance the intake, the loss due to destruction being made up by consumption. The index of protein intake furnished by the existence of nitrogenous equilibrium is of importance as providing a sure standard of adequate consumption of protein.

It is customary to divide the proteins into two groups according to whether they are derived from animal or from vegetable products. The questions, which group of proteins is superior, and whether a reasonable diet must contain some of each, are still under discussion, and a certain disagreement exists among the authorities, though a definite conclusion appears to be now in sight. Some authorities assert not only that protein requirements can be fully satisfied by a diet composed of vegetables, especially cereals, potatoes, fruits, vegetable oil, etc., but further claim that meat products are deleterious in other respects. Hindhede is the chief supporter of this view, and his assistant Madsen is said to have lived on a régime consisting largely of potatoes and margarine for many months and to have kept his

health and vitality. Other authorities, on the contrary, stress the need for the animal proteins, milk, eggs, and meat, and recommend that a high percentage of the proteins consumed (from one-third to one-half) should be provided by these foodstuffs. The ground for this contention is that the animal proteins contain more of the essential amino-acids than do vegetable proteins, and that they are on the whole easier to assimilate. That is, the proteins derived from animal foods have a higher biological value than those of vegetable origin. The balance of informed opinion appears to be in favour of the animal proteins both on the above grounds and because it is very difficult to devise a diet from which milk, eggs, and meat have been excluded which will be satisfactory not merely as regards proteins but also as regards other essential dietary needs (especially vitamins). Thus the recent 'Report on the Physiological Bases of Nutrition' submitted to the Health Organization of the League of Nations by twelve leading authorities of six countries, declares without discussion that 'During growth, pregnancy and lactation some animal protein is essential, and in the growing period it should form a large proportion of the total protein.'

On the other hand, the most recent and exhaustive study of proteins, contained in a 'Report on the Protein Component of the Human Diet' by Professor E. F. Terroine,[5] comes to the conclusion that 'There is no *need* to include proteins of animal origin in the diet of man, whatever the stage of life considered and whatever the nature of the need to be satisfied.' This conclusion is based on exhaustive investigation, and M. Terroine remarks that 'In recent years, attention has been so much concentrated upon the provision of an adequate supply of minerals, and especially of vitamins that certain physiologists and a fair number of dietitians seem to have forgotten, if not discounted, the predominant importance of energy requirements.'

We must pause a little longer over M. Terroine's remarkable report, for it contains much that is new and important. Terroine is able to shed much light on the hitherto unsolved problem of the optimum protein intake; indeed, he appears to have arrived at a definite solution of this question. By means of various formulae it is possible to determine exactly the pro-

tein requirements at various periods of life—growth, maintenance, pregnancy, and lactation. First of all a table of coefficients of 'digestive utilization' is drawn up for the various common foods containing protein. This table shows the proportion of protein in each foodstuff which the organism can digest. A second table is then drawn up giving the 'biological value' of the foodstuffs. The biological value is the 'degree of ability of proteins to satisfy nitrogenous needs', or in other words the proportion of protein which, when digested, can actually be used by the organism for the creation or maintenance of tissue. As we saw above, the body daily expends a certain amount of nitrogen, and in theory the amount of nitrogenous substances absorbed would be exactly equivalent to the loss. 'If, however, whilst containing all the necessary constituents . . . the food proteins contain them in proportions very different from those demanded by the body, then, clearly and inevitably, the organism will have to waste the useless or over-abundant components in order that a sufficiency of the other requisite materials may be provided. In such a case a given amount of protein destroyed in the organism cannot be fully replaced by an exactly equal amount in the food; more will be required, and the quantity will be the greater the less the composition tallies with the needs of the body.'

Now when the coefficient of digestive utilization and the biological value are known, and when the nitrogen expenditure (which, in the case of a man weighing 70 kilogrammes, is approximately 3 grammes per day) has been determined, it is possible to calculate accurately the quantity of protein, whether of a single substance or of a mixture of substances, which will satisfy the maintenance requirements of the organism. The formula is as follows:

$$\text{Maintenance} = \frac{\text{specific endogenous nitrogen expenditure} \times 100 \times 100}{\text{Biological value} \times \text{coefficient of digestive utilization}}$$

Terroine works out this formula in the case of wheaten flour: 'The protein content (of wheaten flour) is 111 grammes per kilogramme, the Digestive Utilization coefficient is 96·8, the biological value 50. For body maintenance in an adult of 70 kilogrammes weight, we shall therefore need:

$$\frac{18{\cdot}75 \text{ grammes} \times 100 \times 100}{96{\cdot}8 \times 50} = 42 \text{ grammes of protein, or}$$

$$\frac{42 \times 1{,}000}{111} = 379 \text{ grammes of wheaten flour.'}$$

The formulae of protein requirements for growth and for pregnancy and lactation naturally differ from the one given for maintenance, since in the case of the former the body needs nitrogen not merely for making good the wear and tear of tissue, but also for the creation of new tissue. It would be tiresome here to go into the details of these other formulae, nor is it necessary: the general principles are the same.

Thus, by means of these formulae, the protein requirements of man at any period of his life, and for any proteinous food or combination of foods, can be accurately determined. This is a very great advance; we shall see its practical consequences when we come to discuss the question of dietary standards.

Another important and novel result of Terroine's investigations is his demonstration, on the basis of these formulae, that *any* food substance, with three negligible exceptions, which contains protein at all, is capable of satisfying fully the nitrogenous needs of the organism if it is taken in sufficient quantities to cover the calorie requirements. Terroine illustrates this fact by an examination of two substances—maize and rice—which are both relatively poor in proteins.

'If maize flour is taken,' he says, 'the low biological value of which shows it to be the least satisfactory of protein foods, the quantity required to cover the 2,400 calories of body maintenance and energy expenditure in an adult would be about 650 grammes. These 650 grammes contain 60 grammes of proteins, whereas the needs can be satisfied by 38 grammes of a biological value of 50, which is that of maize.'

'Again, if rice is taken—which is very poor in proteins—about 700 grammes will be needed to meet energy expenditure, and this amount will provide 43 grammes of proteins. Now, on the basis of the biological value (85) of the total proteins of this cereal, $\frac{19 \times 100}{85}$ equals 22.3 grammes would be needed. The margin between the actual intake and the minimum requirement thus remains considerable. And if the food intake is increased for energy reasons—low temperature leaving a deficit of heat production to be made up, or intensive work—

the protein supply will follow the upward trend and still further exceed the nitrogen needs of the body.'

Professor Terroine does not, however, deduce from these facts that a diet consisting of a single food substance is to be recommended. Quite apart from the fact that such a diet would not supply the required vitamins and minerals, it is undesirable also from other points of view, not least of which is its unpalatability and monotony. Indeed, not the least interesting and important part of Terroine's report is his observations on 'supplementing', which we must now briefly consider.

The problem of supplementing, Terroine declares, is 'to ascertain whether the mixing of various proteins in a composite diet has any effect upon their respective properties and, if so, in what way and to what extent'. The biological value of proteins, on which as we have seen their usefulness depends, varies greatly between the different food substances, ranging from around 100 for meat and milk, to around 50 for certain grains. The question then is: is it possible by combining in the diet proteins of high with those of low biological value appreciably to raise the biological value of the total proteins consumed? Whether or not this is possible depends, of course, on the amino-acid composition of the (two or more) proteins in question; that is, on whether the amino-acids of the combined proteins supply the nitrogen needs of the body more satisfactorily than either protein separately or at least as well as the better of the two proteins. For in order properly to constitute supplementing, the biological value of the combination should be *definitely higher than the arithmetic mean of the individual* values of the proteins.

Now, by determining the amino-acid composition of the various foodstuffs, it is in fact possible to discover definite combinations which will greatly increase the biological value of the proteins concerned. A striking example is given by Terroine: 'Supplementing may be asserted to occur as between white flour (biological value of 52) and beef (biological value 69), since a mixture of these two, in proportions of two-thirds for the former and one-third for the latter, gives a biological value of 73, whereas the arithmetic mean would be 57. On the other hand', he continues, 'no supplementing can be said to

occur as between white flour (52) and ovalbumin (85), since, when mixed in the same proportions, they yield a biological value of 66, whereas the arithmetical mean would be 62.' Professor Terroine gives the following table of typical protein combinations in which supplementing has been shown to occur, and which are suitable for body maintenance:

White flour + whole egg
White flour + milk
White flour + meat
Maize flour + milk.

Thus, by judicious combinations of proteins, such as those suggested in the table, in which supplementing takes place, 'it is possible to raise the mediocre or medium protein to the level of the best'.

The main conclusions of his investigation of supplementing Professor Terroine sums up as follows: 'The certain superiority of all mixed diets and the necessity of recommending, in human nutrition, the use of foods from the greatest variety of sources; the futility of including large quantities of protein of animal origin in the diet, since its presence greatly enhances the value of vegetable protein; the certainty that food protein requirements, as calculated above on the basis of a monotonous diet of a single vegetable food having a comparatively low protein quality, can be still further diminished by providing a mixed diet consisting either of various vegetable products (cereals and legumes) or a small admixture of animal products (milk or meat).'

Carbohydrates and Fats

The chief nutritive function of carbohydrates and fats is to supply energy. Unlike proteins they cannot create tissue; they are 'the *food* of organisms rather than their living substance'.

Carbohydrate is produced by the action of the sun on the chlorophyl of green plants which causes a reaction between carbon dioxide and water and thus forms the organic compounds that we call carbohydrates. The most important of the carbohydrates are sugar and starch. These are changed into glucose by digestive ferments in the mouth and stomach. It is from glucose that the energy for muscular movement is derived.

Carbohydrate is, indeed, useful for other purposes besides the production of energy; it may be transformed into fat and stored in the body in this form ready to be used for the production of energy when required; it serves to spare the breakdown of protein; and it helps in metabolizing fat.

It is uncertain whether fat serves any other purpose than the production of energy. There is some reason to believe that it may, but the evidence is
fat and carbohydrate are
interchangeable', that is,
'may vary within wide limits without producing metabolic disturbance'; although too high a proportion of fat may lead to ketosis. Fat is useful and pleasant as a concentrated form of fuel, having a far higher caloric value than either carbohydrate or protein; thus it reduces the bulk and adds to the palatability of the diet.

Thus far we have been treading sure and solid ground. The theory of calories and of the functions of proteins, carbohydrates, and fats was well established and even in part perfected by the end of the nineteenth century. The view of the body as a thermodynamic machine and of foodstuffs as the upkeep and the fuel of this machine has been proved with the lapse of time to be essentially correct, and the details of the picture have been filled in and in many cases completed. Graham Lusk, the great American authority on the physiology of nutrition, has written: 'In the fuel factor and the repair factor lie the essence of the science of nutrition.' 'The thermodynamic principles', Burnet and Aykroyd declare,[6] 'established by Lavoisier and a long series of scientific workers rest on a secure foundation and provide the basis of indispensable methods of measurement.'

As far as this part of the science of nutrition is concerned the only important question that still remains open and in which extensive research and experiment is still needed is the problem of standards, that is, the amounts of the various food substances to be eaten in order to insure the best possible state of health and well-being. It is obvious, for example, that the nutritional requirements must vary according to age, sex, environment, physical condition, and occupation; but few precise conclusions have yet been reached in this field. We

shall discuss this question at a later stage, and shall find that even here substantial agreement, of a provisional character at any rate has been achieved on a number of important points, and the possibility of exact measurement is in sight.

But students of nutritional science were becoming increasingly conscious of the fact that a diet which contained all of the known essential food constituents did not insure optimum health. In 1881, Lunin, a German investigator, had discovered that mice fed on a synthesized diet composed of proteins, carbohydrates, fats, and inorganic constituents could not live and that something else in addition was necessary for the maintenance of life. From his results obtained from synthesized food substances, he drew the conclusion that 'a natural food such as milk must therefore contain besides these known principal ingredients small quantities of other and unknown substances essential to life'. Several other investigators found that dietary deficiencies persisted in the presence of an adequate caloric intake. The quest led to a new field of research in the science of nutrition and resulted in establishing a causative relation between a number of widespread diseases and the deficiency in the diet of small amounts of substances playing an indispensable role in nutrition.

Vitamins

We now turn to the discovery and function of vitamins. The work of Eijkman to which we shall refer in the course of our discussion on beri-beri had demonstrated (1897) the existence of a 'certain something' in unmilled rice and rice polishings the lack of which produced disease. The indication that there existed some essential dietary constituents apart from those already known to the science of nutrition encouraged a group of investigators to probe into the problem. Experimenting on synthetic diets consisting of protein, fat, carbohydrates, inorganic salts, and milk, a Dutch physiologist, Pekelharing, confirmed Lunin's conclusion and found that milk contained an unknown substance which even in very small quantities was of paramount importance to the maintenance of health. He published his results in 1905, thus lending further proof of the findings of Grijns (1901), and drew the conclusion that

'undoubtedly this substance not only occurs in milk but in various foodstuffs both of vegetable and animal origin'.

'No animal can live upon a mixture of pure protein, fat, and carbohydrate; even when the inorganic material is carefully supplied, the animal still cannot flourish,' wrote Hopkins in 1906. He further said: 'The animal body is adjusted to live either upon plant tissues or upon other animals, and these contain countless substances other than the proteins, carbohydrates, and fats. *Physiological evolution, I believe, has made* some of these wellnigh as essential as are the basal constituents of the diet. . . . The field is almost unexplored, only it is certain that there are many minor factors in all diets of which the body takes account. . . .' He foresaw 'that developments of the science of dietetics will deal with factors highly complex and at present unknown'. His own experiments with young animals showed that a diet adequate in the normal constituents was unable to maintain growth without the addition of small quantities of milk, and that some alcohol-soluble organic substance in milk would supply the missing factor found necessary for growth. By plotting the results of a series of these experiments he showed how the inclusion of milk in the diet conditioned the well-being of the animals—the curve of the milk-fed group rose steadily until the supply of milk was withheld, when there was a sharp decline. On the other hand, the curve of the non-milk group sprang upwards on the introduction of milk and crossed the peak of the curve of the other group. It was obvious that some unrecognized substance possessing extraordinary potency must needs be present in milk. This food factor later received the name of Vitamin A.*

According to present knowledge, there are five distinct classes of vitamins designated by the letters A, B, C, D, and E; *and they are defined as being 'definite tangible substances* wholly necessary for the maintenance of life'. Aykroyd says of

* The word 'Vitamin' was coined in 1911 by a Polish scientist, Dr. Casimir Funk, while working in the Lister Institute, London. He spelled the word 'vitamine', the terminal syllables being an indication of chemical [illegible] discovered in rice polishings, which prevented beri-beri, was essential for life.

them that they are 'food substances of no fuel value, but which are necessary to life in the higher animals and which they cannot themselves manufacture'. McCarrison observes: 'Vitamins do not themselves contribute to the energy supply of the body, but they facilitate the utilization by it of proteins, carbohydrates, fats, and salts.' And elsewhere the same authority writes: 'Vitamins are not foods in the sense of tissue builders or producers of energy, they have not been isolated, and their nature and composition are unknown. What is known of them has been learned from feeding experiments on animals. Two are essential to growth and maintenance; the third is necessary for normal nutrition and the prevention of scurvy. Without vitamins . . . food is dead. . . . They are obtained from the vegetable kingdom; plants appear to have the power of synthesizing them, while the animal does not.'

This passage is interesting not only as giving a clear summary of the functions of vitamins, but as showing what rapid advances in this part of the science of nutrition are being made. Since McCarrison wrote (1921) two more vitamins, D and E, have been discovered, most of them have been isolated in pure form, and one, C, has been made synthetically in the laboratory.

The fact that vitamins are present in foodstuffs in very small quantities and that it has proved extremely difficult to isolate them, has placed very great obstacles in the way of their discovery and has retarded it until recently. But the investigations in regard to these five vitamins have come to a stage where we may draw certain definite conclusions from a large number of experimental data. Each of these substances, even in an extremely small quantity, is known to have specific relations to certain structures and functions of the body. McCarrison[7] sums up these relations as follows: 'Vitamin A to epithelium and nerve; vitamin B to the gastro-intestinal tract, nervous system and skin; vitamin C to the cement substance that binds the cells of the body together; vitamin D to the bones and teeth; and vitamin E to the reproductive system.' By ensuring the functional efficiency of these different structures, each of these vitamins tends to afford protection against disease. The vitamins are links in a chain of essential food substances necessary *for normal metabolic processes. In other*

words, the vitamins are not only mutually related but their efficacy is dependent upon the adequate supply and utilization of other food components. The aim and purpose of a 'balanced diet' are to bring about and maintain nutritional harmony so that it may contribute to the development of normal health. In the following chapter we shall describe some of the diseases caused by nutritional disturbances. We now attempt to summarize our present knowledge in regard to the availability of each of the five classes of vitamins.

Vitamin A

This is known as the fat-soluble vitamin, because it can be dissolved by fat, and by ether and other substances in which fat itself is soluble. Vitamin A and carotene have the same physiological action and carotene has been called the 'precursor' of vitamin A. The action of the sun upon green plants produces the substance known as carotene, and this in turn is converted into vitamin A in the liver. For this reason liver is one of the most important of the foodstuffs containing vitamin A. One of the richest sources of this substance is cod-liver oil but a study of various other liver oils has shown that other fish oils, such as salmon and halibut, may be more than one hundred times as rich in the vitamin as a good Newfoundland oil. The liver fats of the sheep, calf, and ox are also rich sources of vitamin A. Vegetable oils are very poor in this substance. Other foods rich in vitamin A are whole-milk—and it is much more abundant in the milk of pasture-fed than stable-fed cattle; fat-containing milk products such as butter; tissue fats, kidneys, and eggs. *Ghee*, i.e. clarified butter prepared from goat's milk, is also a source of this vitamin. Fresh green vegetables and carrots, and certain fruits (e.g. tomatoes, bananas, dates, mangoes) contain carotene which can be transformed into vitamin A in the human body. Germinated cereals and pulses contain it in moderate amount.

Vitamin B

The water-soluble vitamin B is of a highly complex chemical structure and six or seven fractions of it have been identified. Two of these, B_1 and B_2, which have certain well-marked differences in physical and chemical properties, are of great

importance in dietetics. B1 and B2 frequently occur together as, for example, in dried brewer's yeast; but they may also occur separately. Thus the white of egg contains B2 without B1, while wheat-embryo is rich in B1 and poor in B2.

Vitamin B1 is widely distributed in nature, being particularly abundant in the germ and pericarp of cereal grains and in legume seeds. It is also present in yolk of egg, liver, nuts, certain fruits (especially bananas, oranges, lemons, grapefruit, apples, pears, prunes), and in various vegetables (such as tomatoes, spinach, cabbage, lettuce, carrots, and potatoes). The leafy portion of green vegetables contains it in fair amount but the richest source of this vitamin is brewer's yeast. Milk, fruits, and muscle meats are relatively poor in it. Vitamin B1 is relatively resistant to heat but is destroyed by prolonged cooking above the boiling-point of water. Since it is readily soluble in the water there is risk of losing a great deal of it if foods containing it are boiled at the higher temperatures and the water thrown away. The water used in cooking unpolished rice should not therefore be thrown away, as it contains the vitamin. Vitamin B2 is less sensitive to heat than vitamin B1. It is particularly important to notice that, while whole cereal grains and pulses are rich in vitamin B1, their content is considerably reduced by milling. All milled cereals, such as polished rice, are therefore poor in this substance.

The richest sources of vitamin B2 are dried brewer's yeast, lean meat, fish, milk, cheese, eggs, peas, peanut meal, green leafy vegetables, and tomatoes. It is not abundant in whole cereal grains and root vegetables.

Vitamin C

This is abundant in *fresh* fruits and vegetables, particularly the citrous fruits. Among vegetables, parsley, tomatoes, green chillies, cabbage, young leaves of radish, other green leafy vegetables, and green plantain contain fair amounts. Legumes, otherwise poor in vitamin C, develop this substance when sprouted. To a lesser extent it is present in unpasteurized milk, at least during the summer when the cows are on pasture; and very small quantities are also found in meat.

Vitamin C and ascorbic acid are the same, and since paprika is a very fruitful source of ascorbic acid, it has been used for

making concentrates of vitamin C. Meantime the chemical structure of this vitamin has been discovered by Zsent-Gyorgyi, and it is now possible to produce it synthetically in the laboratory.

Vitamin C is the most unstable of the vitamins; although acidity seems to increase its stability. It is easily destroyed by cooking and especially by methods of tinning or preserving; hence stress must be laid on the value of *fresh* fruits and vegetables. Processes of tinning are, however, beginning to be devised which do not injure the vitamin C content of foodstuffs. Burnet and Aykroyd recommend that 'public health authorities, in drawing up regulations about food preservation and sterilization, should bear the problem of vitamin C destruction in mind'. Fruits and vegetables in storage under ordinary circumstances lose a considerable portion of their vitamin C content.

Vitamin D

Discovered by McCollum, who was also responsible for the discovery of vitamin A, it was the first of all the vitamins to be isolated in a pure form. For a long time, however, it was confused with the fat-soluble vitamin A, partly because its most plentiful source, cod-liver oil, was known to contain vitamin A and to be at the same time one of the cures for rickets. It is not very widely distributed in nature, its chief source being liver and yolk of egg; summer milk and butter contain it in small quantities; and it is especially abundant in fish liver and fish oils. It is absent from vegetable fats. It is the only vitamin which, as far as is known, can be formed in the body by the action of the ultra-violet rays of the sun. Food substances may also be activated in the same way or by artificial ultra-violet irradiation.

Vitamin E

This is fat-soluble and fairly widely distributed in natural foods such as cereals, green leafy vegetables, and in various kinds of vegetable oils. Wheat-germ oil is the richest source of this substance. It is heat-resistant and retains its potency under acid or alkali treatment.

There are as yet no exact quantitative data as regards the

importance in dietetics. B1 and B2 frequently occur together as, for example, in dried brewer's yeast; but they may also occur separately. Thus the white of egg contains B2 without B1, while wheat-embryo is rich in B1 and poor in B2.

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upon the organism resulting from the deficiencies of these inorganic substances.

The energy-producing foods do not in general contain all these inorganic substances and they must therefore be supplied in leafy green vegetables and fresh fruits. From a dietetic point of view, the first four of the elements mentioned above are of chief importance, the rest being supplied in sufficient quantities in most ordinary diets. Calcium, phosphorus, iron, and iodine, however, are often present in inadequate amounts. We must therefore briefly consider the function of each of them and enumerate the foodstuffs in which they are to be found.

Calcium is necessary for the proper formation of the bones and teeth; the promotion of bone-calcification is closely associated with the presence of both calcium and vitamin D. Calcium is equally required for the clotting of the blood and the maintenance of the heart-beat. There is a constant supply of calcium in the blood, estimated at 8 to 11 mg. per 100 c.c.; thus, the body contains more calcium than any other of the inorganic elements, and 99 per cent of it is to be found in the bones. The chief sources of calcium are milk, egg-yolk, cheese, black treacle, green vegetables of various kinds, watercress, dried figs, and almonds. The calcium intake is particularly important during pregnancy and lactation, and in infancy and childhood when the bones are still being formed.

Phosphorus is also necessary for the formation of the bones, and for the brain and nerves. This element is the chief partner of calcium. It has been shown that the anti-calcifying effect of many cereals is due to their deficiency in available phosphorus. Milk, cheese, egg-yolk, lean meat, liver, fish of all kinds, whole wheat, spinach, nuts, almonds, are some of the foodstuffs which contain phosphorus. An absolute deficiency of it is not common among human beings, but it is a problem of great importance in the feeding of livestock, for large areas of land are lacking in it; and in these areas human diet may also be deficient.

In 1838 a Swedish chemist named Berzelius showed that the red colouring matter of blood was capable of absorbing much oxygen and concluded that this was due to the iron in this pigment. His conclusion has been confirmed by physiologists, who find that this element is essential for the formation of

human need for these vitamins, but Nature is not niggardly in their supply. An adequate intake of a reasonably varied diet that includes fresh vegetables, fruits, milk, and milk-products would satisfy the normal requirements of vitamins in health. The Advisory Committee on Nutrition, appointed by the British Ministry of Health, considers that the supply of vitamins and also of inorganic substances would be assured if the daily diet contains one pint of milk, one orange or tomato, or a helping of raw salad, one ounce of butter or vitaminized margarine; if a moderate amount of cheese were included in the diet, or if some sort of fish, such as herring, appeared in the winter menu once a week, or in default of fish if half a teaspoonful of cod-liver oil were taken once a day.

In therapeutic diets vitamin adequacy is estimated in accordance with the circumstances of the patient. In the treatment of chronic gastro-intestinal disorders, or of chronic infections, or in the case of expectant mothers, the intake of vitamin B1 should be, for example, higher than its normal requirement. The nursing mother requires from two to five times the normal amount for her own needs of vitamin B1 if she is to supply enough in the milk to provide the offspring with this substance.

Inorganic Substances

In addition to the proteins, carbohydrates, and fats which are needed for tissue repair and for energy, and the vitamins that are equally necessary for normal growth and maintenance and for protection from disease, the body requires certain inorganic substances which, though they are only needed in small quantities, are no less essential than vitamins. The tissues of the body contain no less than fifteen chemical elements which are constantly being thrown off and must be replaced. The most common chemical elements entering into the composition of tissues in addition to carbon, hydrogen, nitrogen, and oxygen, are calcium, phosphorus, iron, iodine, potassium, sodium, magnesium, sulphur, and chlorine. These salts make the ash which is left after the combustion of food. Animal foods supply acid ash, such as sulphates, phosphates, and chlorides; and vegetable foods and fruits alkaline ash, such as carbonates. In the next chapter we shall refer to the deleterious effects

Investigations have shown that for mineral metabolism it is necessary to maintain a ratio between the essential mineral constituents. One example of the importance of this ratio may be cited here. Diamard[8] was able to produce rickets in young rats by adding iron to their diets to such an extent as to reduce their phosphorus retention. An addition of phosphate, on the other hand, diminished the utilization of ingested iron.

Iodine is an important constituent of thyroxine—the chief internal secretion of the thyroid gland—and therefore its supply is necessary for ensuring the proper functioning of the metabolic process which is largely controlled by the gland. The iodine content of foods varies with the locality as well as with the season. Sea salt and sea foods are rich in iodine; shrimp, crab, lobster, salmon, oysters, contain a high percentage. The richest source is cod-liver oil. Milk, especially goat's milk, contains a small quantity of iodine. Among condiments, ginger, black pepper, coriander, and cloves are comparatively rich in iodine.

Two Main Groups of Food Substances

These are then the essential food-constituents. Before we discuss the principles of practical nutrition work it is useful to emphasize that *these food-constituents may be divided into* two main groups, one consisting of those which are known to supply energy; the other providing the materials necessary for the maintenance of the functions of the body as a whole and of its constituent parts. In the first group are included the foods rich in fats and carbohydrates and in the second those rich in 'good' proteins, inorganic substances, and vitamins. Because the foodstuffs in the first contain nutrients which yield muscular energy, heat (calories), they are classed as 'Energy-bearing'; and those in the second which provide nutrients lack or insufficiency of which results in poor health or disease are known as 'Protective'. This classification of foodstuffs, though not precise, may help us to understand the principles of modern dietetics. The relative food values of both the groups are shown in Table I, and from this we may form an idea how it is possible to obtain in practice a correct balance between them. A large variety of different combinations of the two groups can be sug-

haemoglobin, which carries oxygen through the blood stream to the tissues. The richest sources of iron are lentils, egg-yolk, whole wheat, spinach, prunes, dates, and raisins.

TABLE I*

'Energy-bearing' and 'Protective' Foods

Food	*'Good' protein*	*Minerals*	*Vitamins* A	B	C	D	
Milk	++	+++	+	+	+Ø	+Ø	Highly protective foods
Cheese	++	++	+	+	—	—	
E Eggs	++	++	+	++	—	++	
E Liver	++	++	+	++	—	+	
E Fat fish (herrings, etc.)	+		+	+	—	++	
Green vegetables, salads	+	+++	+	+	++	—	
Raw fruit, fruit juices		+++	+†	+	++	—	
E Butter	—	—	+	—	—	+Ø	
Cod-liver oil	—	—	+++	—	—	+++	
Yeast	+	+	—	++	—	—	
Meat (muscle)	+	⊥	—	+	⊥	—	Less protective and non-protective foods
Root vegetables, tubers	/		+*	+	+	—	
Legumes (dry peas, lentils)			—	+	—	—	
E Cereals, bread (wholemeal)	+	⊥	⊥	+	—	—	
E Cereals, bread (white)			—	—	—	—	
E Cereals, rice (polished)			—	—	—	—	
E Nuts	⊥		—	++	—	—	
E Sugar, jam, honey			—	—	—	—	
E Margarine, olive oil and other vegetable oils			—	—	—	—	

pasture.

* Taken from Interim Report of the Mixed Committee on the Problem of Nutrition, League of Nations, June 1936.

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TABLE II*

The structural formula of food substances

THE FOOD SUBSTANCES

ENERGY

FATTY ACIDS

Butyric	$CH_3CH_2CH_2COOH$
Caproic	$CH_3CH_2CH_2CH_2CH_2COOH$
Caprylic	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2COOH$
Lauric	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$
Myristic	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$
Palmitic	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$
Stearic	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$
Oleic	$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_2CH\ CH\ CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$

HEXOSES

Galactose	Glucose	Laevulose
CH_2OH	CH_2OH	CH_2OH
HO—C—H	HO—C—H	HO—C—H
H—C—OH	HO—C—H	HO—C—H
H—C—OH	H—C—OH	H—C—OH
HO—C—H	HO—C—H	C=O
CHO	CHO	CH_2OH

STRUCTURE

AMINO ACIDS

Glycine	$CH_2(NH_2)COOH$
d-Alanine	$CH_3CH(NH_2)COOH$
l-Serine	$CH_2(OH)CH(NH_2)COOH$
d-Valine	$(CH_3)_2CH\ CH(NH_2)COOH$
l Leucine	$(CH_3)_2CH\ CH_2CH(NH_2)COOH$
d-Iso-leucine	$(CH_3)(CH_3CH_2)CH\ CH(NH_2)COOH$
l-Aspartic acid	$CH_2COOH—CH(NH_2)COOH$
d-Glutamic acid	$CH(NH_2)COOH—CH_2—CH_2COOH$
d Hydroxy-glutamic acid	$CH(NH_2)COOH—CH(OH)—CH_2COOH$
d-Arginine	$NH_2—C(=NH)—NH\ CH_2CH_2CH_2CH(NH_2)COOH$
d-Lysine	$CH_2(NH_2)CH_2CH_2CH_2CH(NH_2)COOH$
l-Cystine	$CH_2—S—S—CH_2$; $CH\ NH_2$, $CH\ NH_2$; $COOH$, $COOH$
l-Methionine	$CH_3S\ CH_2CH_2CH(NH_2)COOH$
l-Phenylalanine	$C_6H_5CH_2CH(NH_2)COOH$
l-Tyrosine	$HO\ C_6H_4CH_2CH(NH_2)COOH$
l-Tryptophane	(ring)—C—$CH_2CH(NH_2)COOH$; CH; NH
l-Histidine	$CH=C\ CH_2CH(NH_2)COOH$; N, NH; CH
l-Proline	$CH_2—CH_2$; CH_2, $CH\ COOH$; NH
l-Hydroxy proline	$HO\ CH—CH_2$; CH_2, $CH\ COOH$; NH

UNIDENTIFIED SUBSTANCES

(VITAMINS)

A B₁ B₂ C D E

INORGANIC ELEMENTS

Na K Ca Mg Fe
Cl P S I

gested in order to satisfy the dietary requirements of normal individuals. It should be borne in mind that a diet containing too high a proportion of energy-bearing foods is as harmful as a diet providing excessive proteins; protein starvation on the other hand results in stunted growth and reduced vitality. Or, a diet deficient in vitamins and inorganic constituents offers no protection against ill-health and disease. Indeed, the correlation between the two groups is of great importance since a diet must be judged as a whole. A familiar illustration of the existence of such a correlation in nature is found in the composition of human and cow's milk; in human milk energy-bearing substances total 88 per cent and those required for structure 12; in cow's milk energy-bearing substances form only 67 per cent, leaving 33 per cent for structure.

In Table II we have the structural formula of food constituents. In our discussion on protein we have mentioned that the 'biological value' of various proteins in human nutrition depends largely upon the amino-acid constitution. Proteins exist in colloidal form and are broken down into simpler compounds which are known as amino-acids. While fatty acids and carbohydrates are effective sources of energy, amino-acids are able to fulfil the dual function of supplying energy to the body as well as building-materials for its structure. The chemical radicals of fatty acids and carbohydrates show a marked similarity in their structure, but those of amino-acids are complicated and varied. All these radicals are dispersed and utilized by the body during the processes of digestion and assimilation.

Dietary Standards

The question of dietary standards, that is the problem of answering the questions: What constitutes an adequate diet? What are human requirements as regards calories, fat, protein, vitamins, etc., and in what proportion should the various food factors be combined? is of great difficulty and no conclusive answer, universally agreed to, can as yet be given. The science of nutrition has, however, advanced to a stage where we may have an objective standard derived from a large number of experimental data, and certain recommendations can be made at least as regards the energy-producing foods.

There are two ways of assessing the individual's calorie requirements: what may be called the direct and the indirect methods. The direct method is by the use of the calorimeter described above. It has been well established by this method that the basal metabolism rate of an average individual is from 65 to 75 calories per hour, or about 1,700–1,800 per day. Any sort of physical exertion adds a certain number of calories to this basal rate. Thus eating adds about 10 per cent; sitting up in a chair about 8 per cent; ordinary movements may add as much as 29 per cent. All these bring the total calories up to about 2,200 per day. More violent exercise, such as walking, adds still more, and Lusk, from whom these figures are taken, concludes that an individual pursuing a sedentary occupation consumes about 2,500 calories per day. These must be supplied to him in his food if he is to be properly nourished and not to use up his own reserves of energy.

These figures may be checked and confirmed by the indirect or statistical method of investigation. This consists in ascertaining how many calories are in fact consumed by average persons in ordinary circumstances when their choice is in no way restricted. A great deal of such material has been collected, and it has been found to be in substantial agreement with the conclusions drawn from calorimeter tests. A standard somewhat higher than that proposed by Lusk has in the past been generally accepted, and the figure of 3,000 calories per day has become famous in nutritional investigations because it was the one adopted by several of the early investigators in this field such as Voit, Atwater, and Rubner. The modern tendency is toward a slightly lower standard in the neighbourhood of that suggested by Lusk. Thus the Conference on Standards of the Health Organization of the League of Nations, while adopting the 3,000 standard for reasons of convenience of comparison, remarked that it was definitely high and that 'a figure of 2,700 or 2,800 would be nearer the mark'. The recent Report of the Technical Commission of the Health Organization lays it down that 'An adult, male or female, living an ordinary everyday life in a temperate climate and not engaged in manual work, is taken as the basis on which the needs of other age groups are reckoned. An allowance of 2,400 calories net per day is considered adequate to meet the needs of such an

individual.' The Report continues: 'The following supplements for muscular activity should be added to the basic requirements:

Light work up to 50 calories per hour of work.
Moderate work up to 50–100 calories per hour of work.
Hard work up to 100–200 calories per hour of work.
Very hard work up to 200 calories and upward per hour of work.'

The Report then gives the following table of coefficients and calories for other ages. The figure 2,400 is taken as the basis (unity) and the requirements of other ages are expressed in terms of it:

Age (years)	*Coefficient*	*Calories*
1–2	0·3	720
2–3	0·4	960
3–5	0·5	1,200
5–7	0·6	1,440
7–9	0·7	1,680
9–11	0·8	1,920
11–12	0·9	2,160
12 and upwards (male and female)	1·0	2,400
Women: Pregnant	1·0	2,400
Nursing	1·25	3,000

The Report further comments: 'The muscular activities characteristic of every healthy child and adolescent necessitate additions to the basic requirements shown above. It is suggested that the activities of children of both sexes from 7 to 11 years be considered as equivalent to light work, of boys from 11 to 15 years as moderate work, and of girls from 11 to 15 upwards as light work. Allowance must also be made for women engaged in household duties, whether pregnant or not; these have to be reckoned as equivalent to light work for eight hours daily.'

We should refer here to an interesting computation made by Aykroyd of daily energy requirements of a carpenter, 11 stone in weight. It is as follows:

	Calories
8 hours' sleep at 65 calories per hour	520
2 hours' light exercise at 170 calories per hour	340
8 hours' carpentry at 240 calories per hour	1,920
6 hours' sitting at rest at 100 calories per hour	600
The total requirements for the day	3,380

In the chapter where we discuss some of the main features of Indian dietaries, we shall refer to what little information there is about the scale of energy requirements of average individuals of different age and sex in India. It is necessary to bear in mind that a diet may be adequate in its caloric values but it may be still deficient from the point of view of maintaining a proper nutritional balance. Many of the sophisticated foods may be actually high in caloric value but deficient in protective food constituents. The calorie is not the only criterion by which food should be valued. 'No one will of course seriously maintain', observes Cathart,[9] 'that nutrition can ultimately be reduced to the satisfying of the energy demands: the calorie factor may be regarded as strictly secondary to the supply material. We do not live on calories, yet all our general estimates of food requirements are quite properly for the most part made in terms of calories. Calorie value is simply a very convenient physical standard for the assessment of diets, but merely because such a standard has proved of great utilitarian value there is no real justification for placing this standard as the foundation stone of hypotheses framed to offer an explanation of cellular activity. Many writers are obsessed with the idea of the calorie, forgetting that the organism is certainly not a heat engine. It is perfectly true that calories are a measure of heat, but it must not be forgotten that we do not consume actual heat units but only potential heat-giving substances which can eventually be degraded to the form of heat and be measured as such. The thermal aspect of nutrition is unduly stressed, for, while heat may be a necessary product of tissue activity, it is, after all, a by-product.'

In determining dietary standards, the emphasis should be laid on the qualitative aspects of food, providing an optimum diet required for the individual, and the efficacy of these standards has to be judged by their relation to health and power of resistance to disease.

The question of the amount of protein to be consumed is more difficult. Burnet and Aykroyd remark: 'There is no existing "standard of protein intake" which rests on the sure ground of experimental evidence, and the question, What is the optimum protein intake? hotly debated by physiologists,

physicians, economists, and dietary faddists, cannot be answered.' Some authorities recommend a low protein intake, others a high one; and the evidence seems to be conflicting.

On the one hand it is alleged that a high protein intake may cause renal hypertrophy and other injury to the kidneys. Newburgh, McCollum, and other investigators have carried out extensive experiments on rats whose diets contained from 30 to 40 per cent of protein, and have found evidence of renal lesions. Others, on the contrary, having fed rats on a diet containing 70 per cent of protein have observed no adverse effects. On the other hand, it is pointed out that races whose diet is rich in protein are superior in physique and energy to those whose diet contains little. As an example of this two East African tribes have become famous, the Masai and their neighbours the Akikuyu. The former live on a diet composed largely of 'meat, milk, and blood', the latter on one composed of cereals, tubers, plantains, legumes, and green leaves. The Masai are taller, stronger, and in general physically superior to the Akikuyu. 'But the diet of the Akikuyu', remark Burnet and Aykroyd, 'as compared with that of the Masai, is deficient not only in protein, but also in fat, and certain vitamins and mineral salts.' And in general it is the case that few conclusions can be drawn from the superiority of the races whose protein intake is high, for their diet differs also in other vital respects from that of races subsisting on a low protein intake.

The result of M. Terroine's researches, which approach the problem from the physiological point of view, is the formulation of a more definite and precise answer to the question of the standard of protein intake than any that has yet been given. We have explained above how it is possible to arrive at a fairly exact measurement of protein requirements at any period of life once the coefficient of digestive utilization and the biological value of the protein foods are known. As we saw, the requirement is a variable dependent upon the biological value of the different proteins, and therefore the amount varies for each protein or combination of proteins. 'For a man of 70 kilogrammes', says Terroine, 'the requirement will be expressed by the formula $\frac{3 \times 100}{N}$, where N is the biological value of the food concerned'—and the number 3 is the specific

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connection, whether upon the rat or the sheep or the pig, are in complete concordance; as soon as a certain level is exceeded, which may obviously vary according to the quality of the protein administered, the nitrogen gain not only ceases to rise but it decreases and, as a first consequence, the gain in weight becomes smaller. A still further rise of protein intake would greatly retard development.'

Finally, on economic grounds, the use of protein to supply energy needs is to be deprecated. With very few exceptions the foods rich in protein are very much more expensive than those composed largely of carbohydrates. And to the actual cost of the foods, moreover, one has to add one-third to allow for the loss of energy entailed by the specific dynamic action. M. Terroine concludes that: 'An abundance of protein in the diet for the purpose of meeting energy requirements is thus nonsense twice over—i.e. physiologically and economically.'

As in the case of calories, so in that of proteins, the modern tendency is to a smaller rather than a greater consumption. Thus Rubner's standard of 127 grammes, Attwater's of 125, and Voit's of 118 have given place to the standard of 100 proposed by the Advisory Committee, the 80–100 of Tyszka, and Burnet and Aykroyd's suggestion of 70–100. Finally, the Report of the Technical Commission says: 'In practice, the protein intake for all adults should not fall below one gramme of protein per kilogramme of body weight.' For a person weighing 150 pounds, this works out at about 68 grammes per day.

So great a change in the standards recommended—a decrease of very nearly half, from 127 to 68—may cause surprise, and even doubt as to the precision of any of these standards. There is much truth in the remark of Burnet and Aykroyd that 'physiologists, in drawing up dietary standards, are largely influenced by the dietary habits of their time and country'. It must be admitted that up to the present time the recommended standards are at best only approximate, and cannot claim absolute validity. With the work of Professor Terroine, a standard of protein intake resting on a more scientific and experimentally verified basis appears to be in sight. We have seen that Terroine insists that protein intake should be strictly limited to that required for the building up or replacing of nitrogenous materials. Commenting on the standard proposed

endogenous nitrogen expenditure for a man of 70 kilogrammes. With this formula it is possible to determine accurately for every protein food the quantity that is required, as soon as its biological value is known.

Terroine insists that a consumption appreciably above this amount is not to be recommended. The extra protein beyond that needed to supply nitrogen is, of course, used by the organism for the creation of energy; but on general physiological grounds it may be said that the consumption of protein to supply energy is undesirable. Terroine speaks strongly on this subject: 'The problem which arises at this point. . . is that of the comparative value of the proteins on the one hand and the ternary foods on the other. Now, on every ground, whether physiological or economic, the former prove to be markedly inferior. Whether the needs to be satisfied are merely those of energy expenditure on function, or whether they comprise expenditure both on function and on the performance of mechanical work, what the system demands is glucose; the administration of protein involves straightway a loss of 35 per cent of the potential energy supplied, owing to the operation of the specific dynamic action. Whenever, during the cold season or in cold climates, the need is for heat production, because the current conditions of life (clothing, heating, housing, work) leave a deficit to be made up in this respect, a greater proportion of protein in the diet is admissible, since the heat output entailed by the specific dynamic action is then turned to account. But even in such a case, fats will be much more favourable, for they contain twice the energy per unit of volume. If to these considerations there is added the fact that proteins leave waste products which make extra demands upon the kidney functions, it will be realized that the use of such foods to supply energy is not only pointless but completely irrational.'

Furthermore, at least in the case of growth, the consumption of too large a quantity of protein actually impedes the metabolism of nitrogen. 'It must not be forgotten', says Terroine, 'that there is absolutely no advantage to be gained by increasing the protein intake above the amount necessary to meet total specific endogenous expenditure, and the needs of protein production for growth. The results of observations made in this

It will be seen that in all these standards the larger proportion of calories is supplied by carbohydrate, though in the more recent ones fat also supplies a high proportion, indeed more so than appears at first sight because fat has a much higher caloric value per gramme than protein or carbohydrate. Thus protein and carbohydrate produce 4·1 calories per gramme, while fat produces 9·3 calories. On the basis of the Standard of the Advisory Committee the proportions of calories supplied by the three energy-producing food substances would be approximately: protein 14 per cent, fat 30 per cent, and carbohydrate 57 per cent. In this connection we would refer to an interesting suggestion made by Lusk. He said that it would be advisable to sell foodstuffs by the 100 calories as a means of promoting economy so that the consumer may get some idea of the actual food value he obtains for his money.

A reference may here be made to various standards suggested for India. McCarrison's estimate of a dietary standard for the southern part of India is as follows: protein 90–100, fat 80–90, and carbohydrate 360–450 grammes intake per day. According to Aykroyd, a well-balanced diet should consist of 73 grammes of protein, 74 grammes of fat and 408 grammes of carbohydrate supplying total calories of 2590.

'It is at present impossible to deal satisfactorily with the problem of vitamin requirements from a quantitative standpoint.' And much the same situation exists as regards the inorganic substances.

We have, however, abundant evidence of the importance of calcium for the growing child and of the form in which this requirement may be adequately satisfied. The main conclusion, supported by numerous and varied experiments, is, to quote Sherman,[10] that 'for children of all ages from 3 to 13 years, inclusive, an average intake of not less than one gram of calcium per day (about twice as much as the maintenance requirement of an average man) is needed to support an optimum rate of storage in the normally growing child'. But it has also been demonstrated that better storage results when this substance is furnished mainly in the form of milk, than when one-half of the milk is replaced by vegetables of equal calcium content, even though the vegetables be selected and prepared with the greatest care to make them as acceptable to the children.

by the Technical Commission, he says: 'When we go back to the old rule of one gramme of food protein per kilogramme of body-weight, we may say that the margin we are thereby allowing is extremely generous if the diet is varied; for a person of 70 kilogrammes body-weight, it will have the effect of supplying the organism with at least three times the amount of protein needed to meet specific nitrogenous requirements, if the food given is of high quality; even with the poorest foods, requirements will be met nearly twice over.'

In the ordinary diets of Western countries carbohydrates supply from one-half to two-thirds of the fuel or energy requirements of man; while fat provides from one-fifth to one-third. In poorer communities less fat and more carbohydrates are used, while among the richer classes the reverse is the case. The Advisory Committee of the British Ministry of Health recommends a fat intake of 100 grammes and a carbohydrate intake of 400 per day. With this recommendation Burnet and Aykroyd appear to be in general agreement, but they remark: 'We have no knowledge as to the optimum proportions of these food factors in the diet.' The Technical Commission says laconically: 'Fat must be a constituent of the normal diet, but the data at present available do not suffice to permit a precise statement of the quantity required.' And about carbohydrate requirements it is silent.

We may sum up these remarks on standards of intake by reproducing from the Burnet-Aykroyd Report a Table of dietary standards put forward by various authorities as suitable for average men:

TABLE III

Dietary Standards

	Protein	*Fat (in grmms.)*	*Carbo-hydrate*	*Calories*
Voit	118	56	500	3,055
Rubner	127	52	509	3,092
Atwater	125	125	450	3,520
Advisory Committee (Min. of Health)	100	100	400	3,000
Playfair	119	51	531	3,140
Tyszka	80–100	60–80	500	3,000

N.B.—The Advisory Committee recommends 37 grammes, Tyszka 40 grammes of animal protein.

The names in the right-hand column are those of the authorities responsible for the suggested standard. Burnet and Aykroyd sum up the situation with regard to vitamin standards as follows: 'Satisfactory quantitative data being absent, we must emphasize the necessity of a very abundant supply of the known vitamins. There is no evidence that any diet composed of natural foodstuffs contains vitamins in such excess as to produce harmful effects, and, on the other hand, we know that vitamin deficiency produces the most serious consequences.'

Practical Deductions from Nutritional Research

We may now ask what practical conclusions can be drawn from the wealth of well-established and newly discovered facts in the science of nutrition, a brief résumé of which we have attempted to set forth in this chapter. Let us glance back over our results, summarize them, and show how they may, and should, affect our actual diet.

One of the most outstanding facts that emerges from our study is that the science of nutrition has two branches. One branch deals with the theory of calories, and treats the body as a thermo-dynamic machine for the production of energy; the other branch considers the body as a living and growing organism whose cells and tissues require constant replacement and are subject to the attacks of various diseases and ailments from which they must be protected. Neither of these views of the body is adequate by itself, for the body is *both* an organism *and* a machine; and it has been found that the science of nutrition can only progress if both aspects and functions of the body are constantly borne in mind.

We have seen that historically the theory of calories was discovered first, although logically and physiologically it should come second, for without the organism there would be no machine. The historical priority of this aspect of nutrition is probably partly due to the fact that the science was first

of pure crystalline vitamin D in olive oil) which has been found equal to that of 0·025 micrograms (0·025γ) of crystalline vitamin D ($C_{28}H_{43}OH$). As regards vitamins B2 and E, the present knowledge of their nature and possible complexity did not justify the adoption of standards and units for them.

According to Orr and Leitch[11] the minimum requirement of iodine is 45γ for adults and 150γ for children of school age. It is estimated that 5 mg. of absorbed iodine per year would be sufficient for an adult. It is important to note that considerable heat is lost through sweat. Now, sweat contains various mineral substances. The loss of these substances by perspiration must be replaced; and it would seem that the quantities required in a warm climate like that of India are greater than in the cooler climate of Europe. Thus in Europe the loss of heat by evaporation is 25 per cent, while in the tropics it is as much as 40 per cent.

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TABLE IV

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Vitamin A	4,200 international units*	(Rose)
Vitamin B1	300 ,,	(Cowgill)
Vitamin C	600 ,,	(Rose)
Vitamin D	50–250 ,,	(Hess & Lewis)
Phosphorus	1·32 grammes	(Sherman)
Calcium	·68 grammes (1 gr. for children, 1·6 gr. for pregnant women)	(Sherman)
Iron	15 milligrammes	(Sherman)
Iodine	14γ	(Von Fellenberg)

* With the manufacture of numerous kinds of vitamin preparations and their extensive use both in prophylactic and therapeutic treatments, it became necessary to adopt certain standards and units of vitamin potency. The methods of estimating vitamin potency are still rather cumbrous and the second conference on vitamin standardization held in London in 1934 under the auspices of the Permanent Commission on Biological Standardization of the League of Nations Health Organization considered the possibility of adopting standards based on accurate tests. The conference recommended the adoption of pure β-carotene ($C_{40}H_{56}$) as the International Standard for vitamin A, defining the unit as 'the Vitamin A activity of 0·6 microgram (0·6γ)' of pure β-carotene. For vitamin B1 the unit should be 10 milligrammes of the International Standard adsorption product. The Unit of Vitamin C activity should be 0·05 milli-

The names in the right-hand column are those of the authorities responsible for the suggested standard. Burnet and Aykroyd sum up the situation with regard to vitamin standards as follows: 'Satisfactory quantitative data being absent, we must emphasize the necessity of a very abundant supply of the known vitamins. There is no evidence that any diet composed of natural foodstuffs contains vitamins in such excess as to produce harmful effects, and, on the other hand, we know that vitamin deficiency produces the most serious consequences.'

Practical Deductions from Nutritional Research

We may now ask what practical conclusions can be drawn from the wealth of well-established and newly discovered facts in the science of nutrition, a brief résumé of which we have attempted to set forth in this chapter. Let us glance back over our results, summarize them, and show how they may, and should, affect our actual diet.

One of the most outstanding facts that emerges from our study is that the science of nutrition has two branches. One branch deals with the theory of calories, and treats the body as a thermo-dynamic machine for the production of energy; the other branch considers the body as a living and growing organism whose cells and tissues require constant replacement and are subject to the attacks of various diseases and ailments from which they must be protected. Neither of these views of the body is adequate by itself, for the body is *both* an organism *and* a machine; and it has been found that the science of nutrition can only progress if both aspects and functions of the body are constantly borne in mind.

We have seen that historically the theory of calories was discovered first, although logically and physiologically it should come second, for without the organism there would be no machine. The historical priority of this aspect of nutrition is probably partly due to the fact that the science was first

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proteins enter the body they are decomposed in the digestive system into their constituent acids, which in turn are absorbed into tissue. Much progress has been made in the investigation of the constitution of the various proteins and in determining the kinds and amounts of amino-acids that the organism requires. The time is in sight when it will be possible to express exactly the quantity of protein to be consumed and the combinations which provide the most useful constituents for tissue-building.

Proteins alone, however, are not sufficient to ensure good health. Vitamins and minerals are also required. These substances are neither tissue-builders nor energy-producers, but vitamins are essential for the proper metabolism of other foodstuffs and for the protection of the body from disease, while *minerals are required in order to replace all those mineral* elements in the tissues which are being used up in the processes of life. The discovery of vitamins was one of the most important steps forward in the science of nutrition. Not only did it suddenly provide a solution to the hitherto mysterious problem of the aetiology of certain diseases, such as beri-beri, keratomalacia, and rickets; it showed, and this was if possible more important, that the old theory that all dietary necessities could be adequately covered by a sufficient supply of calories was radically faulty. It became apparent that, quite apart from the specific diseases caused by lack of vitamins, a very large amount of general ill-health, reduced power of resistance, and susceptibility to infection could be ascribed to the same cause. The emphasis in dietetic standards was thus shifted from the problem of quantity, which according to the old caloric view was what chiefly mattered, to the problem of quality. The question changed from, what is the optimum quantity of food to consume, to, what, given an adequate supply of calories, is *the optimum proportion of* the various foodstuffs *in the diet?* The former question was comparatively easy, and had been answered with a fair degree of accuracy by the end of the last century. The new question has not yet been fully answered. Much still remains to be discovered about vitamins; the standards of vitamin measurement are still in a rudimentary stage, and it is impossible to solve the problem of intake until the difficulty of precise measurement has been overcome.

approached, as we have shown, from the point of view of chemistry and physics rather than from that of medicine or biology. However this may be, the energy-producing function of the body was well established by the end of the nineteenth century. The quantity of energy daily expended by the body and hence the quantity that must be furnished to it by way of food had been determined with considerable accuracy. It remained for later investigations merely to give precision to principles already clearly defined. The exact function of the food substances known as carbohydrates, fats, and proteins as producers of energy has now been fully established. In short, the theory of calories provides us with an instrument of measurement which is invaluable in determining the amounts of the energy-bearing foods which are required by the organism. The *practical* result of this branch of nutrition is to show that energy is chiefly derived from the carbohydrates, particularly flour of various kinds, sugar and glucose, and from the fats. It should be especially noted that the caloric value of fats is twice that of either carbohydrates or proteins (9·3 calories per gramme against 4·1) and that fats therefore provide a concentrated and palatable source of energy. Finally, the proteins, while they may be used to supply energy if the need arises, are not to be recommended for this purpose both because they are physiologically wasteful—may even be detrimental if taken in large quantities—and economically extravagant. The theory of calories, then, and the caloric value of the various foodstuffs have been firmly established on scientific principles, and it seems probable that little more remains to be discovered concerning this branch of nutrition.

The other branch of nutrition—that which deals with the body as an organism—though only lately discovered, has made great progress within recent years, and important new facts are constantly being brought to light. The body is a complicated matrix of cells and tissues. For a long period both before and after birth these tissues are in a process of continual growth, and even after growth has ceased the tissues are being constantly worn out or used up and must be replaced if the organism is to continue in a healthy state. It has been shown that the tissue-builder of the body is protein, or rather the animo-acids of which the proteins are composed. When the

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'Once the consumption of "protective" foods is assured, elasticity in the remainder of the diet is permissible and choice may be allowed free range. Meat, which some class among the "protective" foods, in moderation, is a useful and palatable article of diet, supplying first-class protein and vitamin B2; glandular organs and blood are, however, richer in vitamins and mineral salts. Unmilled cereals are richer than milled cereals in proteins, mineral salts and vitamins, and, for this reason, American workers have recommended that one-third of the cereal should be in unmilled form; the same opinion is also being advocated in France. This, applied to the moderately varied diets of Western civilization, seems a reasonable idea, to which may be added the suggestion that children and pregnant women should consume wholemeal bread. The greater the quantity of cereal in the diet, the more important it becomes that the more nutritive parts of the grain should be consumed. . . . Dietary requirements, thus stated, seem remarkably simple; there is nothing here that could not be readily grasped by an uneducated peasant or manual labourer.

This does not mean, however, that no recommendations can be made. The British Advisory Committee on Nutrition in their memorandum to the Ministry of Health put forward *five* criteria which in their judgement should be considered in assessing a diet. They are: (*a*) the caloric supply per person; (*b*) the quantity of 'good' protein; (*c*) the supply of inorganic substances; (*d*) the vitamin content; and (*e*) the absolute and relative amounts of protein, fat, and carbohydrate. Enough is already known to indicate accurately certain principles of reasonable and 'balanced' diet.

First, an adequate supply of energy must be assured. This should be derived largely from carbohydrates and fats, in proportions that may vary within wide limits according to taste. Although, as we have been emphasizing, the problem of the supply of energy is not the all-inclusive one it was long thought to be, yet it is highly important, in view of the fact that there are still, even in England, many millions of people whose diets are inadequate in caloric value. Thus energy requirements must remain the foundation on which the superstructure of nutrition may be erected.

Secondly, enough proteins must be consumed to supply, during growth, the amount required to build new tissue, and during adult life, to make good the wear and tear that is continually going on. The amount of protein required will vary according to the kind of protein used and to the combinations in which it is consumed.

Thirdly, care must be taken to include in the diet a sufficiency of vitamins and minerals. Except in the case of expectant mothers and of infants, the average diet of the well-to-do classes of the West generally contains an adequate supply of these substances. Almost universally, however, there exist striking deficiencies in the diet of the poor. The foodstuffs which contain an assured supply—such as fresh fruit and vegetables, milk, eggs, and liver oils—are almost everywhere so needlessly expensive that they cannot be purchased by the poor in quantities sufficient to ensure an adequate provision of protective foods. This is one of the major social problems exposed by the recent advances in the science of nutrition.

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CHAPTER THREE

Some Consequences of Dietary Deficiencies

*

Diet and Disease

'Life is impossible without food; food is the source of the growth, strength, and healthful glow of our body; but, it is irregularity of diet which brings about ill-health'; such is the comment of Susruta,* a Hindu medical writer of ancient India, upon the relation of food and health. What he meant by 'irregularity' is not clear from the text; but, according to Charaka, another exponent of the Hindu science of medicine, health (*sukha*) is described as that condition of the self when all the elements (i.e. humours) work together in harmony. Disease is a disharmony caused by the dissociation of the functional unity of the organism.

In our survey of the development of the science of nutrition we have observed that nutrition is the sum of the physiological processes concerned in the growth, maintenance, and repair of the living body. It is, as McCarrison observes, a function of the body on which condition of body—that is, health—depends.

Recent advances in the study of the relation of diet to health have shown how dietetic deficiency gives rise not only to certain specific diseases but to the conditions favourable to the prevalence of a wide range of illness. It is held that barring infectious diseases and accidents nearly 75 per cent of human ailments may be traced to food deficiency. Gastro-intestinal disturbances, various forms of anaemia, beri-beri, scurvy, rickets, pellagra, osteomalacia, keratomalacia, night blindness, and dental caries—all these have been found to arise from

* Probably he belongs to the tenth or ninth century B.C.

The real problem lies in the fact that in all countries the great mass of the people, mainly because of ignorance and poverty, do not reach the simple standard of dietary excellence demanded by modern nutritional science.'

In the following chapter, where we discuss some of the consequences of dietary deficiences, we shall see what happens to the state of health in the event of a serious reduction in the consumption of the essential constituents which go to form the optimum standard of human diet.

malnutrition due to imbalance of the proper dietary constituents, does seriously interfere with the normal functions of the body. It is common knowledge that famines are usually accompanied or followed by pestilences and that food supply plays an important role in warfare when methods are adopted to cut it off with the object of reducing the physical endurance of the enemy's troops.

But the intimate correlation of diet and disease in day-to-day life is not adequately realized. As public opinion on matters relating to the problems of nutrition and health becomes increasingly enlightened and as researches broaden some of the fundamental conceptions of the incidence of disease, a great step will be taken toward human welfare. Indeed, to quote McCarrison, 'the newer knowledge of nutrition is the *greatest advance in medical science since the days of Lister.* When physicians, medical officers of health, and the lay public learn to apply the principles which this newer knowledge has to impart . . . then will this knowledge do for medicine what asepsis has done for surgery.'

Dietetics, which is concerned with the practical application of the 'newer knowledge of nutrition', now forms an integral part in clinical practice aiming at the maintenance of nutritive equilibrium in the patient. It will be a great advance in clinical medicine when disease is diagnosed not on the basis of local pathological condition alone but on the general physiology of the patient as well as on the state of his nutrition. Diet therapy is coming to be recognized as an important factor in the treatment of many common ailments. Scourges like scurvy, rickets, beri-beri, pellagra, and other diseases related to dietary deficiencies have been brought under control; but these achievements, great as they are, are not so significant for the human race as a whole as the acquirement of knowledge which, by its application to society, will improve *the health of every man.*

In this chapter we shall consider some of the consequences of dietary deficiencies and note what are the characteristic deficiency syndromes of the essential food-constituents. While the causes of what is known as deficiency diseases may be multiple, two main conditions, namely the accessory factor (i.e. vitamins) and the factor to which it is accessory, are essential for their prevention.

nutritional maladjustments. The relationship between the diet and sickness is indeed a matter of lowered vitality and reduced resistance to disease. It has been demonstrated that a direct relationship exists between the price of essential foodstuffs and the epidemic malaria. Finally there are symptoms of indirect effects of dietary deficiencies, the examples of which are well known to trained observers. Retarded growth, loss of nervous energy, restlessness, feeble-mindedness, loss of memory, and various eccentric abnormalities may be regarded as indirect effects of undernutrition or malnutrition.

The function of preventive medicine, as so admirably put by Sir George Newman, is 'the building of a better tabernacle for the soul of man to inhabit'. Owing to the discoveries of bacteriology, disease which fouled that tabernacle was thought of as being necessarily associated with positive agents such as parasites, bacteria, toxic substances, etc. The means of controlling infectious diseases have proved to be a boon to mankind, but degenerative diseases persist. To-day the science of nutrition has widened our conception of the relationship between diet and disease and we have evidence to show that if the physical stamina of an individual is not allowed to be undermined by dietary deficiencies, he does not easily crumble under adverse circumstances. Long ago Francis Bacon maintained that 'the cure of diseases requires temporary medicines, but longevity is to be procured by diets'. It is now established that a liberal allowance of food rich in protective constituents (e.g. vitamins and inorganic substances) provides positive health and prolongs life.

McCarrison[12] found no macroscopical evidence of disease in 1189 rats fed on a well-balanced diet composed of whole wheat, pulse, raw milk, butter, fresh vegetables and fresh meat with fat and bones occasionally. On the other hand 2,243 rats fed on an ill-balanced diet composed mainly of cereals, little or no milk, inadequate fresh vegetables, and fats derived from vegetable sources showed very 'diverse pathological conditions'. He was thus able to induce optimal health in his animals fed with a balanced diet and reared under hygienic conditions.

Clinical observations have established the fact that susceptibility to various forms of infection is closely related to the state of nutrition of the people and that undernutrition, or

It may exist without ocular evidence of waste; but if it is prolonged for any length of time, we have the symptoms of functional disturbances in the absence of an obvious pathological lesion. Thus, the slow deterioration of the physique of a people, their diminished vitality, consequent lack of endurance and resistance and the lack of efficiency in work are, indeed, some of the indications of undernourishment.

Malnourishment is related to any dietetic régime which is deficient not in quantity but in quality. That is, if a diet fails to provide all the essential nutritive substances in correct proportions, it may cause malnourishment. A liberal supply, for example, of energy-bearing foodstuffs without a proportion of protective foods will not maintain normal health. The effects of such partial deficiencies in essential food substances are reflected in lowered resistance to disease and general depression of health.

Malnutrition, however, is in a different category. It is a term not easy to define and 'to be avoided as often as under feeding will do the work'. While the causes of malnutrition are many, inadequate or ill-constituted diet appears all too often as one of the fundamental sources of mischief. 'The word malnutrition',[13] writes the International Labour Office, 'might be best reserved to indicate the state of ill-health of a population or of any group of a population in so far as that state is caused either by undernourishment or malnourishment.' It is not *merely* underfeeding, as McCarrison tells us, but disorder of the function of nutrition brought about 'by the prolonged use of food in which certain essential constituents are either absent or present in insufficient amounts'. While, for example, we have sufficient evidence to conclude that vitamin deficiency *per se* is the initiating factor in the causation of certain diseases, we should remember that by mere inclusion of certain items of food rich in vitamins, the diet is not made satisfactory. Not only should a balance be maintained between the two groups of food substances, namely, energy-producing and protective; but also between the different constituents of each group.

Further, even when a diet is perfect from the nutritional point of view, there may be various factors which interfere with its proper utilization. Chronic infections may, for example, progressively affect nutrition; or 'congenital anomalies' retard

Concepts of Malnutrition

Health is dependent upon (1) adequate food, (2) quality of food, and (3) approximately correct balance in regard to essential food constituents. In our discussion on the question of 'balanced diet' we have explained that in order to achieve nutritional equilibrium a diet should contain the optimal amounts of proteins, fats, carbohydrates, vitamins, inorganic salts, water, etc., required to keep the body neither over- nor under-nourished. Such a diet aims at the restoration and maintenance of health and of physical and mental efficiency at the highest possible level. The problem of ideal nutrition is a complex one, because a series of reactions involved in the intricate processes of metabolic functions in the body is associated with it. While underfeeding, overfeeding, and defective diet may cause nutritional disturbances, there may be other causative factors not directly related to actual foodstuffs. For example, a constitutional defect in an individual or the presence of some forms of infection may seriously affect metabolism. In other words, effective utilization of food by the body is 'the denominator of the equation of nutrition'.

Investigations show that the state of nutrition may also be dependent upon racial characteristics, climatic conditions, social habits, age and sex; but broadly speaking, *basal* needs may be regarded as being approximately the same in different parts of the world.

Before we turn to the definition of such terms as undernourishment, malnourishment, and malnutrition, we should refer to another important factor which determines the level of nutrition. It is the method of cooking.* On it depends, to a considerable extent, the absorbability of the essential food-constituents in a diet.

By under-nourishment is meant a dietary condition in which there is an actual insufficiency both in quantity and in quality of the nutritive substances the body needs for repair and maintenance, and for keeping the body weight at the normal level. It is usually indicated by the loss of body weight, though under-weight is not necessarily an index of undernourishment.

* See p. 203.

opinion always be formed at one inspection at any given moment. For nutrition, like its reverse, malnutrition, is a process and not an event.'

We make this long extract from a distinguished British medical officer with a view to assisting the instructed Indian public in realizing the extent of malnutrition among the various strata of Indian communities. While research may yet yield better methods of diagnosis and classification, a general consideration of all the facts concerning the physical well-being of the Indian population will show that malnutrition is more prevalent than all estimates or statistics indicate.

Methods of Detecting Malnutrition

Since it is rather difficult to set up a definite standard by which the degree of malnutrition may be measured, a number of methods are now employed in detecting the various grades of malnutrition.

The exact determination of an individual's 'state of nutrition' is not so easy a matter as might at first sight appear. The first difficulty to be faced is the meaning of the phrase 'state of nutrition'; how much should be included in this term, and what should be its limits? There are some who would limit its meaning to the very restricted idea of the amount of fleshy covering which envelops the skeleton. But this criterion is not in general satisfactory for judging a person's state of nutrition; for it is by no means the case that thin people are necessarily malnourished, while excesses of fat are no less a sign of defective nutrition than is excessive thinness.

Most authorities in England and America give the phrase 'state of nutrition' a wider meaning. Thus Sir George Newman, Chief Medical Officer of the Ministry of Health, defines it as 'the total well-being and right functioning of the whole body', and declares, as we have already quoted, that height, weight, substance, colour, elasticity, balance, and carriage of body, the effective functioning of the nervous system, heart, lungs, and alimentary tract, the readiness and relative strength of the muscular system, are all relevant to the determination of an individual's state of nutrition. This is of course a very

proper assimilation of food, leading to malnutrition. Among other aetiological factors, environmental conditions, such as prevail in slums and in insanitary Indian villages, are very important. Certain morbid physiological states may give rise to conditions of malnutrition which may not show definite signs even to medical men until they have been exerting their influence for some time. Many forms of dietary deficiencies are insidious because, while their results in an advanced stage are grave and obvious, in their earlier stages they are undiscernible. The continuance of disturbed metabolism is, of course, indicated in general appearance, muscular tone, the texture of the skin and certain characteristics of veins of the individual. The difficulties inherent in the problem of determining malnutrition are clearly stated by Sir George Newman in his report to the Board of Education of Great Britain. He writes:[14]

'Sound nutrition is a general physiological condition which connotes a healthy body in all respects and the good tone and health of its various constituent parts, its brain and nervous system, its muscular, digestive, circulatory, and lymphatic systems. All this means that we must take a wide and comprehensive view of nutrition, which is a state revealing itself in a variety of signs and symptoms. Thus, in endeavouring to estimate a child's nutrition or its opposite (viz. malnutrition), we must think not only of bulk and weight of body, but of ratio of stature to weight; of the general balance and "substance" of the body and of its carriage and bearing; of the firmness of the tissues; of the presence of subcutaneous fat; of the condition and process of the development of the muscular system; of the condition of the skin and the redness of the mucous membranes; of the nervous and muscular system as expressed in listlessness or alertness, in apathy or keenness; of the condition of the various systems of the body, and, speaking generally, of the relative balance and co-ordination of the functions of digestion, absorption, and assimilation of food as well as of the excretion of waste products. It is obvious that these are data which are likely to lead to a much more reliable opinion than the consideration of any one factor or ratio, however expeditiously obtained or convenient in form or practice; and these data will demand a wider as well as a more careful and accurate observation of the whole physique of the child. Nor can any ultimate

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comprehensive definition, but it is one which has gained wide support and has much to recommend it. Naturally other factors besides diet, for example, lack of sleep, overwork, and chronic infective disease, may influence an individual's 'state of nutrition' when understood in this wide sense; but diet still remains one of the most important influencing factors.

The specific methods for assessing the state of nutrition may be divided into three groups: (1) the comparison of certain measurements with a chosen standard; (2) the formation of a general clinical impression of the state of health and development; (3) tests to assess physiological efficiency and to detect incipient deficiency disease. None of these tests is absolutely reliable, but they are the only methods yet available, and when used in combination as, in practice, they frequently are, they furnish a fairly accurate indication of the general state of nutrition.

(1) *The first method, often called the 'anthropometric* measure', includes measurements of height, sitting height and weight, and the comparison of these with a chosen standard for the age. This standard may be either an 'average' or an *'optimum' standard; average if it is arrived at by measure*ments of a large unselected group, optimum if the group upon which it is based is selected on account of its superior physical characteristics. These measurements are then combined in various ways to give a more accurate indication of the exact state of nutrition. One of the simplest classifications, which has been widely and successfully used in the United States, is that suggested by Emerson:[15]

1. Ten per cent or more below average weight for height = 'malnutrition'.
2. Under average, but less than 10 per cent = 'borderline'.
3. Average to 20 per cent above = 'normal' (about 10 per cent above is considered ideal).
4. Twenty per cent above average = overweight.

The Berlin Conference of 1932 on 'the most suitable method for detecting malnutrition due to the "economic depression"' recommended the rather more elaborate 'Pelidisi' method. This method was devised *by Pirquet and widely used in Vienna* after the War, with considerable success. The fundamental formula is as follows:

$$\frac{\sqrt[3]{10 \text{ wt. in grammes}}}{\text{sitting height in cm.}} = N = 1 = \frac{100}{100}$$

In other words, the basal unit, represented by 100, is the cube root of ten times the weight divided by the sitting height. When the sitting height and net weight have been determined, the index figure can be obtained from the Pelidisi table. Schoolchildren whose index exceeds 100 are over-nourished; those whose index ranges from 95 to 100 are normal, and those below 95 are under-nourished. The Pelidisi method has been criticized, however, on the ground that a very small inaccuracy in the measurement of the sitting height greatly affects the result.

Another system of measurement, recently adopted by the American Child Health Association, is known as the A.C.H. index. It is based upon measurement of arm, chest, and hip girth. For routine work the method is advantageous but experience shows that certain adjustments of the index are necessary in order to make it suitable for conditions other than those obtaining in America.

(2) Clinical impression. 'It is generally agreed',[16] write Burnet and Aykroyd, 'that the most satisfactory method of assessing nutritional status is clinical examination by an experienced physician. The disadvantage of this method for public health purposes lies in the fact that no two observers employ the same criteria as the basis of judgment.' The diagnosis of malnutrition in schools in Great Britain is usually based on clinical examination. Various methods have been devised in order to give this clinical impression a more objective character and to make the results comparable. The 'Sacramata' method, also invented by Pirquet, is among the best known and is recommended by the Berlin Conference. The report of this conference thus describes the method: 'The state of nutrition of the human body is clearly evidenced by the blood content of the skin, the condition of the subcutaneous fat layer, the skin tension determined by the water content of the subcutaneous tissues, and the condition of the muscles.

'These various points are appraised according to a scale of values represented by the five vowels of the alphabet arranged in descending order of pitch. The meanings attached to these vowels are as follows: "i", particularly high; "e", increased; "a",

normal; "o", reduced; "u", lacking. The combination of these vowels with the initial letters of the Latin equivalents for the four characteristics, Sanguis, Crassitudo, Turgor, Musculus, yields a descriptive word which expresses, in clinical terms the state of nutrition of the person examined. Thus, "SOCRETAMI" signifies a low blood content of the skin, an amount of subcutaneous fat above the normal, a normal water content, and great muscular development.'

(3) Tests to assess physiological efficiency and to detect incipient deficiency disease. This method of determining the state of nutrition consists of various technical devices to measure physical efficiency and 'fatigability' (ergographic tests); and well-established scientific tests to discover symptoms of specific deficiency diseases (tests for nitrogenous equilibrium, radiological examination, X-ray photographs, and so forth).

Consequences of Underfeeding

A diet must be quantitatively sufficient to yield a reasonable amount of calories to meet the energy requirements of an individual. A condition generally characterized by the lack of this requirement is inanition both chronic and partial. It is produced by a negative balance between the income and output of energy. In the circumstances of famines we have enough examples of the mass suffering and of the pictures so characteristic of inanition.

In the first place, growth is interfered with and retarded through starvation. The consequence of enforced underfeeding in Germany during and after the War was about 20 per cent reduction of the body-weight of the people. Suppression of growth is, of course, conspicuous in children. In adults the arrested growth possibly brings about a state of equilibrium; that is, there may be neither a gain nor a loss in weight.

We have seen that the minimum demand for energy is the amount which is required for basal metabolism. Modern research has thrown much light on the individual components of a diet; and while their importance is rightly stressed, the quantitative assessment of nutritional requirements must remain a matter of primary consideration. Inadequate diet

results in a distinct lowering of metabolic activity which leads to both physical and mental disturbances. It is estimated that under-nutrition as a factor by itself may reduce basal metabolism one-third. Fasting *per se* depresses metabolism, and it has been experimentally demonstrated[17] that men on a reduced diet for long periods undergo profound metabolic changes which are indicated not only by certain physiological reactions such as disturbance of blood composition, neuromuscular efficiency, and changes in the gaseous metabolism, etc., but also by the development of a number of psychological traits and abnormalities. From the psychiatric point of view, the effects of prolonged underfeeding have not yet been adequately investigated; but various traits in the behaviour of those who practice fasting over a long period may be regarded as the possible consequences of disturbed metabolism due to a low nutritional level. Religious mania, crude forms of psychic exhibitionism, egoism of a rather childish character, vanity, and certain types of sexual perversions are noticeable among peoples subject to chronic under-nourishment. It develops morbid nervous conditions and fosters inertia. It is certain that millions of children and adults in India are under-nourished, and if the truth of the old saying—'a hungry man is an angry man'—is not epitomized there in actual life, the reason may also be traced to psychological aberrations which give birth to and nurse the twin evils of fatalism and pessimism in the outlook on life. Aykroyd[17a] rightly observes that 'hungry men make no revolutions; if they break windows it is not as a protest against the greed of the rich but in order to be taken to gaol and given something to eat. Hunger takes a man's courage and self-respect and leaves him a whining cadger of crusts and half-pence.' No Indian can read Knut Hamsun's autobiographical book entitled *Hunger*, in which one finds a vivid expression of his gruesome individual experience, without bringing to mind a poignant picture of the suffering of some of his own countrymen. The fact that they subsist on inadequate food is not a proof that they do not remain hungry: it only suggests that under the circumstances of long continued under-nutrition there may be an adjustment of the body to the lower food intake. But the adjustment does not arrest the progressive undermining of the stamina of the underfed peoples

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gastro-intestinal putrefaction which not merely disturbs normal metabolic processes but may seriously impair the functions of the internal secretary glands (e.g. thyroid, pituitary, adrenal, etc.). The excess of carbohydrates results in fermentation which may lead to diseases of the intestines. Consumption of food in excess of the need of the body is one of the contributary causes of diseases of the heart, circulatory system, and kidneys.

Among the well-to-do classes in India, overfeeding is one of the chief dietary faults. While a study of the psycho-physiological effects of hunger upon a man might elucidate certain peculiar characteristics of the Indian masses, a similar investigation on those who habitually consume more food than is needed would probably throw some light upon their reduced vitality and lessened chances of life.

Deficiencies in 'Energy-bearing' Foods

(*a*) *Proteins*

In our last chapter we have dealt with the specific dynamic action of the protein component and have outlined the nature of the controversy over the quantitative aspects of its requirements for normal health. While the view in regard to the liberal need of proteinous foods may have been modified, there is no disagreement on their value both as 'energy-bearing' and 'protective' foods; but as a body-builder the protein component is even more important. It is 'the noblest of the food constituents', as Liebig called it. If we had not protein in our foods, there would result tissue-starvation even though the supply of carbohydrates and fat were assured.

Deficiency in proteins may result either from the low protein content of a diet or from factors affecting the level of protein metabolism. We have already stated that proteins must be of high biological value and that their quality is more important than their quantity. Nigerian natives, as is shown in the study by McCulloch, have a dietary containing approximately the same amount of proteinous foods as the Scotch families of St. Andrews, but mainly composed of foodstuffs lacking in essential amino-acids.

and they remain susceptible to infectious diseases. And with lowered vitality their capacity as producers also remains low.

The most serious effect of underfeeding is left upon children. Early physical development is a concomitant of the well-being of an individual. What hope is there for children whose growth process has been interfered with by inadequate nutrition? Medical authorities tell us that from the age of two to the period of school-going age underfeeding or even partial deficiency in essential food substances may cause serious damage to the child. Grave deterioration of health and efficiency as caused by underfeeding is rare in most of the Western countries. But partial deficiencies of food substances exist, and 'the influences of such partial deficiencies even when relatively slight'—observe the Medical Research Council of Great Britain —'may be extremely serious when they occur in very early life, and, if we may judge from the results of experiments on animals, an adequate supply of these indispensable dietary components later in life may fail to make good the damage caused by a deficiency in youth. There is also danger that the effect of such a partial or latent deficiency may persist as a chronic condition throughout adult life.'

The truth is that continued under-nourishment not only becomes a predisposing factor in tuberculosis and other infectious diseases but creates a vicious circle by weakening the entire mechanism of digestion. Starvation diarrhoea is of common occurrence in famine areas.

Consequences of Overfeeding

It is not the amount of food we consume but what we are able to digest and absorb that nourishes the body. One may partake of abundant food but may not enjoy good health. Apart from the consideration that overfeeding is economically unsound, it is important to bear in mind that disturbed metabolic process interferes with proper and adequate utilization of the essential food constituents of the diet, and consequently reduces its value. Continued overfeeding may lead to malnutrition.

Overfeeding is harmful to health and exposes the body to several ailments. The excess of nitrogenous foods leads to

deficient in many essential food substances. At any rate there is general agreement in the view that a diet excessive in carbohydrates produces a 'favourable nidus' for the development of chronic ill-health.

(*c*) *Fats*

Fats are 'the highest condensed energy-producers'. That is, they furnish weight for weight more than twice the amount of heat and energy obtained from carbohydrates. Deficiency in fats is usually detected clinically by signs of deficiency in corresponding fat-soluble vitamins. Fats may be of either animal or vegetable origin, and it is only those of animal origin which contain vitamins A and D. Butter, cream, eggs, cod-liver oil, are some of the sources of 'high grade' fats; lard, almond oil, olive oil, cottonseed oil, are classified as low grade. *Vitamins are absent from hydrogenated oils.*

Most of the Indian dietaries are deficient in 'high grade' fats and produce symptoms almost comparable to deficiencies in fat-soluble vitamins. Lack of fats in the maternal diet produces children of low birth-weight, and on this point Balfour's investigation[19] in India, is of considerable interest. She found that the death rate in the first three months of life was very much higher when the birth-weight was low, being 62 per thousand for babies with birth-weight of 5 to 5½ pounds, 333 for those with birth-weight of 4 to 5 pounds, and 840 for those with birth-weight below 4 pounds.

Deficiency in 'Protective' Foods

(*a*) *Proteins*

It has been established beyond doubt that diet poor in protein tends to lower vital activity, and that an adequate intake of 'good' protein is one of the 'factors of safety' in human life. The consequences of protein starvation or excessively low protein supply are discernible in the poor physique and low power of resistance to disease among all poverty-stricken peoples. Protein starvation is regarded as one of the contributory causes of epidemic oedema. Individuals maintained on a low protein diet are liable to functional nervous diseases and attain earlier senility.

(*b*) *Carbohydrates*

Deficiency in carbohydrates is unusual, for they are abundantly supplied through some of the cheapest foods available. More energy can be derived from them per unit of cost than from any other source of nourishment and they are generally more palatable than any other foods. Thus the functional disturbances caused by them are not the consequence of their deficiency but the source of the trouble lies in an excessive consumption. Since a diet made up largely of carbohydrates is likely to be deficient in protein, fat, and other food constituents and may therefore be faulty, we shall consider some of the effects of the dietetic error involved in the consumption of excessive amounts of fermentable sweet and starchy foods.

The objection to the excessive use of cereal foodstuffs and other sources of carbohydrates in a diet is that the amount of carbohydrates which has to be oxidized in the body becomes disproportionately large in relation to the amount of protein present. This is liable to lead to intestinal disturbances, particularly among children. 'Even if the large excess of carbohydrates can be successfully passed on', writes Gray[18] in his monogram on the Food of Japan, 'from the intestine to the blood stream without undergoing fermentation of an undesirable kind, there remains the difficulty of the tissues of the body to deal with more fuel than they require. . . . The consumption of quantity without quality is in some respects more dangerous than starvation, for the latter is obvious and a remedy is sought; the former may remain a hidden source of evil, gradually reducing the vitality of the people.'

Several human ailments, such as periodical headaches, dyspepsia, constipation, gastric and duodenal ulcers, high blood pressure, certain forms of skin disease, and nervous irritability, are caused by the absorption of putrefactive and toxic products, derived from a disproportionate supply of carbohydrates in the diet. The dietary history of patients suffering from functional disorders in gall-bladders, bile ducts, and urinary tracts records invariably an excessive consumption of carbohydrates. The role of carbohydrates in diabetes is well known, and it is suspected that the incidence of cirrhosis of the liver may be related to prolonged adherence to consumption of foods which are largely carbohydrate in character and

vitamin A in liver. Again the cure of scurvy by acid fruits and green vegetables was discovered in the eighteenth century, and it seems probable that it had more than once before been discovered and lost again. It is now known that these foods are able to cure scurvy by virtue of the vitamin C which they contain.

The first real experiment which tended to show the existence of some substance in food theretofore unknown was carried out in 1820 by Magendie, to whom we have already had occasion to refer as the discoverer of the important fact that foods differ in chemical content. Magendie found that a dog fed on white bread and water died within two months, while a dog fed on coarse brown bread and water lived. Magendie did not himself carry his experiments further, but it has since been found that vitamin B1, which is contained in the germ and pericarp of cereals, is lacking in highly milled white bread.

Eijkman, at the end of the nineteenth century, was the first actually to produce and cure a deficiency disease. He was a prison doctor in Java with a hospital full of patients suffering from beri-beri* (*Polyneuritis endemica*). The relation of the disease with lack of a 'certain something' in unmilled rice and rice polishings was first observed by him and subsequently studied by British medical men in India. Paralysis of the legs was one of the conspicuous indications of beri-beri and Eijkman observed one day that the hens in the yard showed the same disability. His experiments showed that one of the principal aetiological factors was related to a diet of polished rice. He was able to induce paralysis in his hens at will by restricting them to a diet of rice from which the entire pericarp and germ had been removed by overmilling. On the other hand, the hens fed on whole unmilled rice remained healthy. Eijkman's investigations were pursued by Grijns, who discovered (1901) that rice bran possessed anti-neuritic properties. Further research showed that these properties are due to the presence of vitamin B1 in rice bran.

We shall now turn to each of the known vitamins and sum up our present knowledge of some consequences of their deficiency in the diet.

* Beri-beri is a Singhalese expression meaning 'I cannot'; that is, the person affected by it is too ill to do anything.

The effects of a diet defective in the supply of proteins are more apparent in children than in adults.

(*b*) *Vitamins*

We have stated in the preceding chapter that man and most other animals cannot synthesize those food substances known as vitamins (except vitamin D) and that they must be taken in the food, either from animal or vegetable sources. From evidence obtained from experimental feeding of animals, it is known that they are sensitive to vitamin deficiency. Although the *exact* functions of these active substances are not known, it is abundantly clear that their deficiency in food leads to specific metabolic disturbances in the digestive, nervous, glandular, and other systems of the body. The symptoms of such disturbances medical authorities have agreed to call deficiency diseases. Even when the specific symptoms are not pronounced, there are positive indications of the impairment of health; and deranged functions of the body tend to lower resistance to bacterial infection.

It should be borne in mind that the importance of these vitamins lies not only in the prevention of certain specific diseases, due to their lack in diet, but also in preventing many states of sub-normal health. It has been demonstrated that an adequate supply of 'energy-producing' foods will not sustain growth activity when vitamins are absent. Generally speaking vitamin deficiencies affect growth with the consequence of diminished nervous energy and even mental agility.

Certain facts about the cure of disease by the use of certain definite foodstuffs, which are to-day explained by the existence of vitamins, have long been known. Thus there is in existence an Egyptian papyrus* dating from about 1500 B.C. which prescribes liver as a cure for hemeralopia or night-blindness. This cure was known also to Hippocrates, who recommended raw ox-liver dipped in honey. Many primitive peoples, e.g. the Newfoundland fishermen, know the efficacy of liver in the treatment of eye-disease. But it is only recently that an explanation of the cure has been given: namely, the existence of

* The following passage in *Ebers Papyrus* is interesting: 'Because the unknown disease was cured by the roast liver of an ox, the disease was supposed to be night-blindness. Also the patients were recommended to hold their heads over the steam rising from the roasting liver. . . .'

the eye.* While the subnormal condition may at the initial stages be rectified by a proper diet plus cod-liver oil, advanced keratomalacia nearly always leads to impairment of vision or to blindness. The prevalence of the disease among the negro slaves on the coffee plantations of San Paulo in Brazil led to a close investigation and its cure was found in a liberal supply of cod-liver oil, which is a rich source of vitamin A or carotene.

Another common eye disease, associated with vitamin A deficiency, is night-blindness or hemeralopia. In the retina of the eye there is a colouring substance, known as visual purple, the formation of which is affected by the deficiency of vitamin A, in some way not understood. Consequently the patient is unable to see in dim lights. Night-blindness is one of the earliest symptoms of keratomalacia. In this connection we should mention Jean and Zentmire's visual test by which they were able to detect partial degrees of vitamin A deficiency 'by testing photometrically the ability of the retina to adapt itself to diminished illumination'.[22]

There is evidence to show that deficiency of vitamin A increases the liability to acute infections affecting the lungs. Prolonged deficiency of vitamin A alters the condition of the mucous membranes, especially of the respiratory and urinary tracts and weakens the defence mechanism of the body. Thus, the lack of vitamin A may play an important role as a predisposing factor in pneumonia, tuberculosis, and other diseases associated with the lungs, through lowering of the body-resistance.

McCarrison[23] came to the conclusion from his experimental feeding of rats that stones in their bladder were produced by faulty diet composed mainly of cereals and deficient in vitamin A. He found that an adequate supply of this food substance afforded protection against stone-formation. Fujimaki[24] in Japan found that a vitamin A free diet has a definite relationship with the formation of carcinoma, but his results have not as yet been confirmed. Disordered liver function may indicate the onset of vitamin A deficiency. Some of the skin diseases are associated with diets persistently deficient in vitamin A. The type of unhealthy cutaneous manifestations, such as dry papu-

* For the symptoms of keratomalacia, see chap iv, p. 141 f.

Vitamin A. It has been demonstrated that without vitamin A the growth of young animals is arrested and they become easily susceptible to infection. Numerous experimental data are now available in support of the conclusion that it is an essential food factor for growing children and without it they show definite signs of malnutrition. Mellanby and Green[20] found that 91 out of 93 rats soon developed definite symptoms of lowered vitality when fed with a vitamin A free diet, while not a single case occurred among the 50 rats used as controls. A distinguished Danish physician, Bloch, drew the attention of the Danish Government to the high incidence of keratomalacia and other forms of eye diseases, especially among poor children, as a consequence of selling butter and other animal fats to Germany during the War.

But the need of vitamin A is not confined to the young. Since it promotes vigour and stamina and also maintains the mucous membrane in a healthy condition, vitamin A is necessary for nutritional well-being at all ages. Its adequate supply for pregnant and nursing women is of great importance. One of the underlying factors in many cases of premature birth and foetal and neo-natal death is the deficiency of vitamin A, which is known to affect the quality of mother's milk if it is inadequately supplied in her diet. The infant receives a very limited amount of vitamin A *in utero* and therefore the need for its ample provision, especially at weaning, is urgent. The food of the nursing mother should contain a liberal supply of vitamins.

As early as 1913 Osborne and Mendel showed[21] that animals malnourished from lack of vitamin A exhibited 'a peculiar opthalmia'. Without its presence in diet, the epithelial tissue becomes keratonized, that is, hard and horny; and in this condition it cannot repel those infections which come from micro-organisms. So long as the epithelium is kept intact, there is little chance of such infections. But with the deficiency of vitamin A, the membranes of the eye are affected and the trouble begins in the lacrimal field. Eventually dryness of the conjunctiva sets in, which is often a precursor of a more serious affection. The ulceration of the cornea then exposes the eye to any kind of bacterial invasion. Keratomalacia, which is a destructive form of eye disease, is produced by ulceration of

understood, but the importance of its relation to carbohydrate metabolism has been confirmed by several investigators. It is maintained that physiological disturbance involving carbohydrate metabolism may well be a contributory cause in producing symptoms of beri-beri.

Since vitamin B1 is found in so many foodstuffs, deficiency of it is comparatively rare in the West, where the average diet generally contains a sufficient quantity to prevent, at any rate, the more striking and fatal results of a lack of it. In order, however, to ensure enough of it, it is well, especially when the diet is at all restricted or monotonous, to use wholemeal bread rather than white, for the milling of flour takes away the vitamin. In this connection it is interesting to note that a partial deficiency of this substance may be corrected by increasing the protein and fat contents of the diet.[27]

In the East, where the usual diet of the poor consists largely of milled rice, deficiency of vitamin B1 is very common and outbreaks of beri-beri occur from time to time in consequence. [illegible] in Eastern [illegible] ice-growing [illegible] d by 'spasmodic rigidity of the lower limbs, with muscular atrophy, paralysis, anaemia, and neuralgic pains'. Adults from about 15 to 30 years of age are more liable to the attack of beri-beri than children. Japanese investigators found that the number of cases, especially in youths and adults, is enormously in excess of the number of deaths directly due to this disease and that it leads, as is the case in parts of India, to widespread sickness and incapacitation. Infantile beri-beri can be cured with extract of rice-polishing, which is a rich source of vitamin B1.

But every outbreak of beri-beri cannot be wholly attributed to the deficiency of vitamin B1 in the overmilled rice. It occurs, as is the case with other scourges of the tropics, among the poorly fed population. General under-nourishment, insanitary conditions under which the masses live, and ignorance are indeed some of the predisposing factors which make them liable to suffer from beri-beri. But experience has shown that this disease which takes yearly toll of thousands of lives is easily preventable. In 1878 the incidence of beri-beri in the Japanese navy was about 38 per cent. Baron Takaki, a distinguished

lar skin eruption so common in India, is regarded as the result of long-continued vitamin A deficiency.

In Western countries an absolute deficiency of vitamin A appears to be rare, though there is evidence to show that a partial lack is not uncommon and is very probably responsible for much subnormal health and development.

The results of diet-surveys so far carried out in India and the prevalence of respiratory diseases and the lowered resistance of the people show that their diet is generally poor in vitamin A. And yet this substance occurs abundantly in nature. 'Its bountiful supply', *to quote Sherman*, 'is a bulwark against disease of many kinds.' An adequate intake of milk and milk products, leafy vegetables, carrots, tomatoes, egg-yolk, liver, and fish would satisfy the normal requirement of vitamin A.

VITAMIN B (B1 and B2). It is known that endocrine glands exercise a considerable influence upon various functions of the body. At present it is impossible to say how the physiology of the endocrine system is disturbed by vitamin deficiencies; but that it is involved in some way appears to be established. McCarrison and others have accumulated experimental data which show that the presence of vitamin B complex in the animal body is essential for the health and activity of the gastro-intestinal tract. In its absence or owing to partial deficiency over a long period, the intestinal epithelium is damaged. Long continued deficiency also affects the nervous system; and beri-beri, as already stated, is one of the outspoken symptoms of the extent of damage caused by the lack of vitamin B1.

Several forms of physical ailments, such as gastric ulcer, chronic constipation, defective gastric secretion, deficient lactation, and nervousness and irritability in children may be traced to partial but chronic deficiencies in vitamin B1. Maurer and Loh Seng Tasi[25] thought that it resulted in 'dimunition in learning ability'. Wills and Talpade[26] found in their clinical observations in Bombay that lack of vitamin B in the maternal diet was one of the causes of premature births. It is held that the tissue stores of vitamin B become depleted during pregnancy because of its accumulation in the mammary glands and in the embryo.

The physiological role of vitamin B, however, is not well

men, and that the advanced stage of the disease is often accompanied by gastro-intestinal, nervous, and mental disorders. It is common in the southern districts in the United States of America, where maize is the staple food. In 1913 Dr. Goldenberger was appointed by the United States Bureau of Public Health, to investigate the causes of the outbreak of pellagra. From his observations he concluded that the disease was not infectious and that it victimized chiefly those who lived in an unhealthy environment and were under-nourished. After conducting preliminary investigations in an orphanage where he was able to control the recurrence of the disease by the introduction of milk and a more varied diet, he sought to induce the disease by feeding men upon a series of restricted diets. Twelve convicts were persuaded by the offer of a free pardon to place themselves under Dr. Goldenberger's dietary treatment, and in six months seven out of the twelve showed all the symptoms of pellagra. Further observations on a series of feeding experiments gave sufficient indications as regards the relation of pellagra to deficiency of vitamin B2, although its symptoms cannot be attributed to a single dietary factor.

Maize is also the diet of the very poor in many Central European countries, especially Roumania, Yugoslavia, and south Russia; it used to be the staple diet of the Italian peasant, but a campaign against pellagra undertaken before the War has materially reduced its incidence, so that now it is a rare disease in Italy. As many as 120,000 cases were reported in the United States in 1927, the mortality rate being over 40 per cent. It is particularly common among negroes and poor whites in the Southern States, the death rate per 100,000 inhabitants in the six most stricken States being, in 1930 29·4. In Roumania in 1933 the death rate from pellagra was 15 per 100,000. It is difficult to cope with the recrudescence of the disease because the populations among which it is common are especially poor and especially ignorant. Still, the success achieved by the pre-War Italian Government shows what can be done with perseverance, though the general rise in the Italian standard of living between 1900 and 1914 doubtless had much to do with stamping out the disease.

Vitamin C. The pronounced deficiency of vitamin C affects

naval physician, brought about a remarkable improvement by a radical change in the dietary of the crew, reducing the incidence of the disease to 0·03 per cent within ten years. And this he accomplished by a practical demonstration of the immediate effect of his dietary reforms. He persuaded the Government to plan an experiment by sending out two warships on a voyage to New Zealand and South America with 350 persons on board. The crew of one were provided with the usual diet then rationed in the navy and the other with a new diet scale which included a liberal supply of nitrogenous food and a considerable quantity of wheat and barley. Both the warships were sent along the same route with almost identical conditions. While there was no case of beri-beri on board the ship whose crew were fed with this new diet, the other ship reported as many as 100 cases.

Since deficiency in vitamin B1 impairs the neuro-muscular activity of the gastro-intestinal tract, several other complaints are associated with it. Pronounced deficiency of this substance in the dietary of pregnant women exposes them to the risk of haemorrhage, abortion, still-birth, and dropsy. It has been observed that in South India, where milled rice is a staple food, 'premature expulsion of foetus' and still-birth are more common than in northern parts of India, where wheat enters into the usual dietary.

Owing to its wide distribution in common foodstuffs and its resistance to heat, vitamin B2 is usually present in a normal well-balanced diet. However, it seems to be generally admitted that a diet deficient in vitamin B2 leads to the development of a form of dermatitis, known as pellagra, though it is still obscure whether this is the only cause or merely a contributory factor. The first description of pellagra was given by a Spanish physician, Casale, in 1707, who observed its symptoms in the Asturias and ascribed it to an insufficient diet. In 1771 Frapoli gave it its name, which means 'rough skin'. It is a skin disease which is particularly common among people whose staple article of diet is maize, a cereal which lacks vitamin B2 and whose protein is also deficient in an important amino-acid. In addition to the cutaneous lesions, the nervous system of the victim is affected, resulting in progressive weakness. It is held that the disease is five times more common in women than in

with vitamin C free diets, such as condensed milk. There is also on record the case of spontaneous scurvy in monkeys which broke out in a shipment from India to San Francisco. A diet rich in vitamin C was supplied to the animals and marked improvements took place within a short time. Many of the 39 monkeys were completely cured.

Its main symptoms are a swollen gum and leakages of blood from the vessels into the surrounding tissues. The disease appears in an epidemic form. There were many outbreaks of scurvy during the last War, particularly on the eastern fronts where it was difficult to ensure a diet of fresh foods. It is recorded that in 1916 over 7,500 British soldiers and a large number of Indian troops suffered from scurvy in Mesopotamia.

While acute vitamin C deficiency is not very common, recent observations show that partial deficiency may be far more frequent than is suspected. Its symptoms are often observed among the inmates of public institutions (e.g. prison, asylum, orphanage, and boarding-school, etc.) if the supply of *fresh* vegetables and fruits is inadequate.

Scurvy is not an uncommon disease among infants, because milk is not rich in vitamin C. There is particular danger of it with bottle-fed infants. Hence the importance, now generally recognized in the West, of giving babies a daily dose of orange juice or some other fruit juice rich in vitamin C. With the discovery by Szent-Gyorgyi of the chemical nature of vitamin C and the possibility of its* synthetic production in the laboratory, it should shortly be possible to eradicate for ever a disease which has long been the bane of mankind.

Vitamin D. Vitamin D is one of the factors directly concerned in the prevention of rickets. Its deficiency in diet affects the normal bone formation. Defective bone formation giving rise to such deformities as spinal curvature, bow legs, beaded ribs, knock-knee, etc.; muscular relaxation, gastric disturbances, and nervous irritability are some of the symptoms of rickets. Children suffering from this disease often develop a tendency

* Vitamin C has been isolated in large quantities in crystalline form from paprika or Hungarian pepper. Professor Szent-Gyorgyi was awarded the Nobel Prize for Chemistry.

primarily the intercellular tissue substance in the animal body, and the most serious result is scurvy. Scurvy is for the most part a disease of seafaring men, soldiers, and explorers who may have to subsist for considerable periods on a diet of tinned or preserved foods. The disease seems first to have been described by Hippocrates; it was common in the wars of the Middle Ages and in the great voyages of discovery in the sixteenth and seventeenth centuries. Hawkins, for example, saw 10,000 deaths from scurvy in twenty years. Vasco da Gama in his voyage round the Cape of Good Hope is reported to have lost 100 out of 160 men who accompanied him. The early voyagers dreaded scurvy. Captain Cook was, however, fortunate in arresting the recrudescence of the disease in his second voyage by the provision of germinated barley and cabbage preserved in vinegar. According to Holst, Cartier in 1535, on his second voyage to Newfoundland, cured scurvy by the use of a fresh decoction of pine needles. Lind (1716–94), a British naval surgeon, was one of the earliest investigators who attempted to discover both cause and cure of the disease. In 1752 he published a treatise on scurvy in which he suggested the use of oranges and lemons as an effective cure for the malady; but he did not consider it to be essentially a disease due to a dietetic deficiency, and held the view that, to quote his own words, 'a most powerful and principal cause of scurvy is the moisture of the air, and consequently the dampness of the sailors' lodging'. Thus we see that although the scurvy preventing properties of certain foods were recognized, the dietary cause of the disease was not acceptable to the medical men of the eighteenth century, although in 1720 an Austrian army physician, Kramer, asserted that 'three or four ounces of orange or lime juice will cure this dreadful disease without other help'. It had, however, become established that fresh lemon juice was an effective preventive and it was therefore introduced as a compulsory item in the diet of the British Navy in 1795. During the first decade of the twentieth century, Holst and his associates demonstrated that the lack of some factor associated with the metabolic process was the cause of the disease. Holst and Frolich produced scurvy in guinea-pigs by feeding them on bran and rolled oats. It is interesting to note here that the disease was induced in monkeys by feeding

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certain foods previously inefficacious against rickets became anti-rachitic when irradiated by ultra-violet rays—a discovery due to Steenbock in 1924; secondly when, soon afterwards, [illegible] min D, was discovered. [illegible] tamin D. It is present [illegible] in yeast, from which an extract is made; and also in the human body. It is by means of the ergosterol in the body, therefore, that the sun, playing upon the skin, is able to cure rickets by turning the ergosterol into vitamin D. Thus the deficiency theory of rickets was vindicated and the conflicting evidence harmonized. Shortly afterwards vitamin D was isolated in a pure form.

Vitamin D acts as a catalytic agent in the presence of which the blood is able to absorb calcium and phosphorus. In other words, the function of vitamin D is to regulate the metabolism of calcium and phosphorus in the body. The exact mode of the process is a subject of further investigation. In rickets the amount of calcium and phosphorus metabolized or assimilated is below normal. This has the effect of keeping the bones weak and unformed. The deficiency of calcium and phosphorus may be due either to the diet's lacking these chemicals, or, if the diet is not lacking in them, to a deficiency in vitamin D. For it has been shown that the body cannot retain calcium and phosphorus when given directly; they are eliminated without reaching the blood stream. When vitamin D is supplied, however, it assists in the metabolism of the minerals and calcium phosphate is deposited in the bones. This is confirmed by Professor Pirquets's painstaking investigations into the prevalence of rickets in Vienna during and after the War. He thought that fat-soluble vitamins functioned as an activator for calcium metabolism and recorded a number of cases where the disease was produced in normal healthy subjects by withholding fat-soluble vitamins in their diet.[28]

Mellanby was able to induce rickets in puppies by feeding them on a diet adequate in regard to calcium and phosphorus content but defective in vitamin D. There is also evidence that excessive use of cereals, such as oatmeal and maize, is likely to produce rickets, partly because they contain an anti-calcifying substance which interferes with calcium and phosphorus absorption and partly because they lead to increased

to nasal, bronchial, and intestinal catarrh. Since some of the characteristics of rickets are similar to those of hypoplasia of the bony tissue, medical opinion used to be divided on the question of the aetiology of the disease. In 1840 Chossat described softening of the bones in pigeons fed on a calcium-free diet, and in 1860 Friedleben demonstrated by chemical analysis that rachitic bone contained less calcium than normal. In 1880 Voit was able to induce some of the symptoms of the disease in puppies fed on a diet consisting of meat and lard; but in 1888 Cheadle held that a diet deficient particularly in animal fat was responsible for rickets. McCollum's extensive experiments with the rat yielded much valuable information regarding some of the factors associated with ossification. He was able to produce in the rat a condition histologically identical with human rickets.

The discovery of vitamin D was made more difficult and perplexing because of the mystery in which the aetiology of rickets was for long enshrouded. On the one hand it was observed that diets which were deficient in certain substances, especially liver and eggs, produced rickets which could, however, be cured by adding cod-liver oil to the diet. This seemed to indicate a fat-soluble anti-rachitic vitamin. It was demonstrated that the most potently calcifying diet was rich in fat-soluble vitamin and that its absence resulted in some functional disturbances leading to rickets. On the other hand, at the same time that experiments were being made along these lines by Mellanby (1919) Huldchinsky succeeded in curing rickets with ultra-violet rays, and Hess with direct sunlight. This confirmed an ancient theory, mentioned by Pliny the Elder, that sun was a specific against rickets; and also the observation that the disease was rare in hot and sunny climates but very common in northern, comparatively sunless lands. Huntly, a medical missionary working in Rajputana, Central India, reported in 1885 that although the diet of the poor folk in India was markedly deficient in fat, rickets was not very conspicuous among them; and this he thought was due to some beneficial effects of abundant sunshine. Thus there were two seemingly contradictory explanations of rickets; one ascribing it to climatic conditions, and the other to dietary deficiency.

The clue was found at length when it was shown, first, that

certain foods previously inefficacious against rickets became anti-rachitic when irradiated by ultra-violet rays—a discovery due to Steenbock in 1924; secondly when, soon afterwards, [illegible] min D, was discovered. [illegible] tamin D. It is present [illegible] in yeast, from which an extract is made; and also in the human body. It is by means of the ergosterol in the body, therefore, that the sun, playing upon the skin, is able to cure rickets by turning the ergosterol into vitamin D. Thus the deficiency theory of rickets was vindicated and the conflicting evidence harmonized. Shortly afterwards vitamin D was isolated in a pure form.

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growth without supplying to the bones a sufficiency of calcium, phosphorus, and vitamin D.

It is now clear that there are not less than five distinct preventives and cures for rickets; (i) cod-liver oil; (ii) irradiation of the body by ultra-violet rays or by the sun; (iii) irradiated food, especially milk activated by exposure to ultra-violet radiations; (iv) irradiated basic substance, ergosterol, extracted from yeast; and (v) yeast milk, a biologic product endowed with anti-rachitic potency as a result of feeding irradiated yeast to the cow (or by irradiating the cow directly).

Although the aetiology and cure of rickets have been so triumphantly elucidated, the disease still remains one of the major problems of public health authorities. It is true that since the War the incidence of rickets has fallen considerably, but over large areas of Europe and America, and in northern India and China, it is still rampant. In the poorer districts of most of the great towns in these countries rickets has been found among anywhere from 50 to 90 per cent of the children.

Wilson's investigations[29] in the city of Lahore, Punjab, revealed 607 cases of rickets among 1,482 girls attending the schools. In Bombay it is prevalent among the women and children living in the slum area and it exists in other industrial centres. The problem is one both of poverty and ignorance, but in the face of our present knowledge there can be no excuse for continued failure to solve it. Let us remind ourselves of the established dietary fact that milk is one of the best sources of vitamin D as well as of calcium and phosphorus.

Another effect of deficiency in vitamin D is osteomalacia, the adult form of rickets, in which the bones, particularly the pelvis, are softened and deformed through lack of enough vitamin D to metabolize the available calcium and phosphorus. Recently Wilson and Surie[30] gave a review of 265 cases of osteomalacia in India and they consider that in most of these cases the diet was probably not deficient in calcium or phosphorus, but in vitamin D. The disease generally attacks women and is particularly common in pregnancy, when unusual strain is put upon the bones. Owing to pelvic deformities of child-bearing women, it may in many instances result in still-birth and neo-natal death. It is not very common in Europe, though a milder form appeared in both sexes in post-

War Vienna as a result of the semi-starvation caused by the economic collapse after the War.

In the cities of India and China, however, osteomalacia is of very frequent occurrence among women who practice 'purdah'. It is prevalent in the more crowded parts of the cities. Scott,[31] who has made a study of osteomalacia in India, finds that it is worst among the Mohammedans, who, although their diet is on the whole better, practice stricter purdah; it is less common among the Hindus and does not exist among the Parsi community. Women who work in the fields generally escape it, owing to the vitamin D producing action of the sun. It is unknown among the non-purdah Afghan women.

Osteomalacia can be successfully treated in its early stages by any of the methods mentioned above for rickets; though of course the bones, once bent, cannot be straightened. This horrible disease, which is due not so much to poverty as to ignorance and superstition, could be wiped out by purely educational means. Aykroyd's remark that 'every step toward the abolition of *purdah* is a step toward the abolition of osteomalacia' is endorsed by those who have studied the circumstances of this disease. It is, however, recognized that plentiful sunlight cannot compensate for a diet quantitatively and qualitatively deficient in essential food components.

Burnet and Aykroyd describe dental caries as 'one of the major scourges of modern civilization'. Decayed teeth are a very malignant 'septic focus' and poison the whole system. A flood of new light has recently been shed on the problem of dental caries by Mellanby and her associates who suggest that at any rate its chief cause is deficiency of vitamin D. Commenting upon the relationship between dietary deficiency and teeth, she says:[32] 'The supply of calcium and phosphorus must be adequate. The presence of the anti-rachitic vitamin which diet should contain seems to control the actual process of calcification and is necessary. Cereals act in the opposite way and specifically interfere with calcification.'

The structure of teeth resembles that of long bones, and teeth, like bones, need calcium phosphate. As we know, vitamin D assists in the metabolism of calcium and phosphorus, and Mellanby therefore argues that a deficiency of it must, as it causes rickets in the bones, so produce dental caries. She has

carried out extensive experiments which support her theory; thus the examination of a large number of deciduous human teeth shows that defective calcification does lead to caries. Further she has conducted an important experiment upon four groups of children. Over a period of two years and on the basis of a similar diet in other respects, one group was given in addition treacle, the second olive oil, the third cod-liver oil, and the fourth radiostol (a preparation from Vitamin D). At the end of the experiment all the groups had increased caries, but the last two very considerably less than the others. It is suggested as a result of this and other experiments that if pregnant and lactating mothers and infants were given sufficient vitamin D the children would have strong, white, regular teeth which would be immune from decay. Mellanby's conclusions are not yet universally accepted, but it seems to be generally agreed, among those who are qualified to judge, that lack of vitamin D, though it may not indeed be the sole cause of dental caries, is at least an important contributory factor.

In this connection it is interesting to note that Wilson and Surie[33] in their study of 100 Indian children suffering from rickets found that the more severe the hold of the disease, the greater was the tendency to gross hypoplasia of the teeth.

The occurrence of pyorrhœa is also attributed to dietary errors involving either deficiency in calcium, phosphorus, and vitamins C and D, or excess of carbohydrates and proteins. Further investigations into the increased incidence of dental diseases and their relation to diet are in progress. Meanwhile anthropologists report from their observations that immunity to dental caries and allied troubles disappears among the primitive races as soon as some forms of processed foods are introduced into their dietary.

Vitamin E. There is little or no evidence that the deficiency in vitamin E ever produces pronounced symptoms of any disease; but its lack in diet appears to be one of the contributory factors in human sterility. A diet rich in this substance is helpful in the case of sexual neurasthenia.

It has also been observed that deficiency in vitamin E produces pathological changes in the placenta of rats and eventually leads to abortion. It is reported that cases of habitual

abortion in cattle, and also in human beings, were cured by a liberal supply of feeding-stuffs containing this vitamin.

(c) Inorganic Substances

Inorganic substances are known to control largely the functions of the physical-chemical mechanism of the body. They are essential for the maintenance of physiological equilibrium and fulfil an important role in nutrition. Consequently their deficiency may produce serious nutritional disharmony. The tissues are particularly sensitive to mineral deficiency; 'without the proper balance', observes Bridges, 'of mineral material, there is an immediate alteration in surface tension phenomena as well as osmosis.'[34]

In our discussion on 'balanced diet' we have noted that an adequate supply of inorganic substances is one of the criteria for the evaluation of a diet. They play an important part in maintaining acid-base equilibrium in the body. Here we shall briefly refer to four main inorganic substances and note the consequences of their deficiency in human nutrition.

1. CALCIUM. Experiments with young animals have shown that the deficiency in calcium and phosphates is characterized by a poor deposit of calcium phosphate in the ossifying cartilage. Since calcium metabolism is related to vitamin D, a low level of calcium in the diet is associated with osteomalacia. Diets of patients suffering from this disease show a negative calcium balance, but this deficiency may arise from a disordered metabolic condition even if the diet contains adequate calcium. To ensure a normal relationship between calcium and phosphorus in the metabolic process both elements should be supplied in optimal ratio. Sherman[35] has pointed out that calcium shortage greatly influences the process of iron metabolism.

It should thus be clear that an adequate supply of calcium is singularly important on account of its conspicuous role in metabolic processes. The results of its deficiency in diet are summed up by the chief medical officer of the Ministry of Health, Great Britain,[36] in the following terms:

'A deficiency of calcium during the growth period when the effects of inadequate diets are particularly liable to become manifest, would result in defective development of the bony

skeleton. This is the most obvious effect of such a deficiency, but others less striking, though just as important, would occur. The proper functioning of contractile tissues depends on the presence of a certain concentration of calcium ions in their environment, and as the calcium in the blood is lowered by calcium-poor diets, the contractile elements in the body, e.g. the musculature of the circulatory and alimentary systems, would not play their requisite parts in a proper fashion. There is also evidence for believing that absorption of carbohydrates would be reduced by deficiency of calcium in the blood. Further, the metabolism of calcium is intimately bound up with that of phosphorus and with the function of the parathyroid gland, so that any disturbance of the former is bound to lead to disturbances in the metabolism of phosphorus and in parathyroid function. In addition, since calcium plays a dominant role in maintaining the selective permeability which is an essential characteristic of all living cells, there is probably not a function in the body which would not be adversely affected by continued ingestion of diets low in calcium.'

2. PHOSPHORUS. For the maintenance of healthy tissues of the body, phosphorus is an essential substance. It is needed for all cellular activities and supplies a protective constituent to the nervous tissues. Its deficiency leads to several ailments especially related to depression of vital processes. In those parts of the world where soil is poor in phosphorus, the effects of its deficiency both in human and animal diets may be pronounced.

3. IRON. The amount of iron in foodstuffs is not fully available to the body, and the process of its absorption and utilization is probably dependent upon complex physiological factors not fully understood. But it is known that lack of iron supply is one of the causes of anaemia.

Various types of anaemia are included in the category of deficiency diseases. Recent evidence shows that this disease is very common among infants and in adult women in the child-bearing period. While a diet deficient in essential food substances is likely to affect, in this period, the normal gastric secretion and thereby become a causative factor in anaemia, the iron deficiency plays a decisive part in the development of

the disease. The demand for iron by the foetus during pregnancy has to be met and it must obviously come from a maternal source. Physiologists tell us that the liver of a newly born animal contains weight for weight six times as much iron as the liver of an adult animal and that this iron-content decreases during the milk-feeding period. Hence the necessity for an adequate supply of foodstuffs containing iron to nursing mothers. It is common knowledge that artificially fed infants suffer from nutritional anaemia.

Burnet and Aykroyd quote Mackay as having shown 'that 50 per cent of infants in the East End of London develop some degree of nutritional anaemia from the fourth month onward'. And from some recent observations in Aberdeen it appears that 'of 1,000 women belonging to the poorer classes 50 per cent showed some degree of anaemia, 15 per cent being severely anaemic. . . . *Many of these women considered their condition* of chronic ill-health and wretchedness as normal and accepted it with resignation.'

There is a very high incidence of anaemia throughout India—a fact which must be taken into consideration in an investigation of infant mortality. Nearly 36 per cent of maternal mortality in India may be due to pernicious anaemia developing during pregnancy. Strauss and Castle[17] came to the conclusion that an infant might be born with a normal supply of haemoglobin even if the mother were anaemic; but this 'inheritance' did not fail after a few months to produce anaemic conditions in the infant. This is, they asserted, the result of maternal iron deficiency.

4. IODINE. *Since the discovery by Baumann in 1895 of iodine* as an essential constituent of the thyroid gland, the attention of physiologists has been directed to determine the influence of this mineral in the regulation of the metabolic process. It is found that the metabolic disturbances caused by a deficiency of iodine produce goitre. Peoples living near the sea rarely suffer* from the disease because sea salt and sea foods are rich in iodine. In Japan the incidence of goitre is as low as one per million and its absence is due to the consumption of sea-weed, which contains about 1,000 times as much iodine as any other

* But it is common in Danzig.

food. Mountain or inland inhabitants are often afflicted with endemic goitre. It is, for example, a common disease in certain Himalaya regions, where the rate of incidence frequently rises to 50 per cent. Von Fellenberg, of the Swiss Goitre Commission, studied the distribution of iodine in nature and found that foodstuffs grown in a goitrous region contained less iodine than those from a non-goitrous tract.

Much attention has been paid to the problem of goitre in various countries of late years, and in Switzerland and America steps have been taken to make good the deficiencies of iodine wherever they occur. Thus the water supply of the towns has sometimes been iodinized, iodine compounds have been given to school children, and salt containing sodium iodine has been encouraged.

It should not, however, be concluded that goitre is due to iodine deficiency alone. Stott finds[38] a remarkable connection between endemic goitre and calcium in water in the Himalayan regions of the United Provinces and suggests that an excessive intake of calcium through the drinking water may be an important causative factor. Others hold the view that a diet which is ill-balanced and provides a very low supply of calcium tends to cause goitre. The truth is that the incidence of thyroid disease cannot be ascribed to a single factor: it is related not only to imbalance between calcium, phosphorus, and iodine but also to vitamin deficiency. According to McCarrison,[38a] faulty diet is one of the goitrogenic agents. He enumerates the imperfect constitution of such diet as follows: '(*a*) Excesses of certain substances—fats, fatty acids, and lime. (*b*) Deficiency of certain substances—iodine, vitamin A, vitamin C, protein (in association with vitamin A deficiency), and phosphates (relative to an excess of lime). (*c*) Goitre-producing substances—cyanogen compounds—in certain foodstuffs such as cabbage. (*d*) Insufficiency of certain anti-goitrogenic substances, of unknown nature but other than iodine, present in certain fresh plants such as green grass, alfalfa, the expressed juice of steamed cabbage, and in spouted legumes and carrots.'

Problem of Deficiency Diseases

We may now sum up the problem of deficiency diseases. Lombroso once observed that it was impossible to cure these obvious manifestations of ill-health because he might as well advise his patients to be rich as to have adequate and proper food which they could not afford; while if a patient were rich he could easily be persuaded to correct the errors of his diet and would not suffer from deficiency diseases. It seems almost superfluous to comment on this penetrating remark, which goes straight to the root of the problem. The question, 'Can deficiency diseases be wiped out?' is no longer medical but social and economic. Doubtless much remains to be learnt about the relation of diet to disease, but already medical science is in a position not merely to cure but to prevent a whole series of fatal or debilitating maladies which spring directly or indirectly from malnutrition. Rickets and osteomalacia; scurvy; beri-beri and pellagra; xerophthalmia and keratomalacia—all these could, so far as our scientific knowledge is concerned, be banished from human society. Tuberculosis, dental caries, the commoner forms of anaemia, could be radically reduced if not stamped out. It is not medical knowledge that is lacking; it is the economic system which tolerates widespread poverty that is largely at fault.

Poverty, then, is a factor of fundamental importance in the causation and the prevalence of the deficiency diseases, and in the face of poverty medical science is rendered impotent, as Lombroso points out. It is for this reason that a great deal of emphasis is laid in the present book upon social and economic questions, and our discussion is not confined merely to a summary of the new knowledge of nutrition. With this new knowledge as a sure foundation, the problem which confronts us at the present time is the economic problem of how to apply this knowledge in such a way as to ensure adequate nutrition to the population as a whole. The enormous disparity in incomes which creates a [illegible]
of the very poo[illegible]
industry which [illegible]
nomic system as a whole; and the recurrent crises incident to

that system; these are the problems which must be faced if it is hoped seriously to tackle the question of malnutrition and the diseases which spring from it. The final Report of the Mixed Committee of the League of Nations on the problem of nutrition rightly observes: 'The malnutrition which exists in all countries is at once a challenge and an opportunity; a challenge to men's consciences and an opportunity to eradicate a social evil by methods which will increase economic prosperity.'

It may well be doubted whether in an economic organization where commodities, including foodstuffs, are produced for profit rather than for use, it will ever be possible to ensure to the working masses a really adequate diet. That this system, at *all* events, does not in fact ensure such a diet even in the advanced countries is now fairly widely admitted; and any one who takes a serious interest in nutritional problems must squarely face the possibility that they can only be solved by a profound modification in the economic structure of society.

Meantime, there are palliative measures which can be taken. Some of these we have already discussed; others will be treated at length in Chapters Seven and Eight. The principle involved in these measures has been well summed up by Sir John Orr in his Chadwick lecture. 'It may be assumed', he says, 'that any government would accept as the first essential the necessity for ensuring that every individual in the state shall be able to get a diet sufficient to maintain health. If a system of producing and marketing foodstuffs fails to do this, the State, through its medical and social services, must pay for the treatment for those suffering from an inadequate diet.' Since in fact no state, except the Soviet Union, has yet recognized its responsibility in the first respect, the second alternative—to cure or alleviate diseases or deficiencies which have already appeared—is the only one which remains open. To what extent this has been done in the advanced countries in order to lessen the gravity of deficiency diseases we shall see at a later stage; here we need only remark that the policy of palliating the effect rather than eradicating the cause, which is typical of the present form of society in many fields, is to say the least wasteful and illogical.

CHAPTER FOUR

Public Health and Deficiency Diseases in India

*

General State of Public Health

'The sound nutrition of the individual and the community is the foundation of the public health,' writes Sir George Newman. Indeed the points of contact between the Public Health Service and the problems of nutrition are so intimate that in some of the advanced countries the means and methods of solving dietary deficiencies are made an integral part of the activities of Public Health Administration. While the standard of public health depends largely upon two governing factors—the habits and customs of man and the kind of environment—it is now widely recognized that the diet of a people is of primary importance in making that standard both efficient and progressive.

The state of the public health of a country has to be estimated not merely by the incidence of diseases, but by the conditions of life in which the bulk of its population lives. That the standard of health of the people of India is low is common knowledge; the average expectation of life is about 38 for males and 36 for females, and the death rate is over 34 per mille; but it is important to realize that there is an alarming sign of physical deterioration due to under-nourishment and other causes, which does not effect the mortality rate and yet gives rise to a state of chronic ill-health of the people. Their low vitality cannot altogether be explained away as being the consequence of climatic conditions or other features of a tropical and semi-tropical zone. That the physique of the people was once strong is suggested by the fresco and other paintings

that system; these are the problems which must be faced if it is hoped seriously to tackle the question of malnutrition and the diseases which spring from it. The final Report of the Mixed Committee of the League of Nations on the problem of nutrition rightly observes: 'The malnutrition which exists in all countries is at once a challenge and an opportunity; a challenge to men's consciences and an opportunity to eradicate a social evil by methods which will increase economic prosperity.'

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policy'. With us in India, on the advent of a new constitutional era, the need of formulating a co-ordinated policy is of special importance, not only within the sphere of each Provincial Government but for India as a whole.

Perhaps the most striking feature of the general health of the bulk of Indian peoples is their extremely low power of resistance to infections of all kinds. Malaria takes a heavy annual toll and incapacitates millions in India, and because of their low vitality even milder forms of attack often prove fatal. It is estimated that the number of deaths each year from malaria alone is one million, and 'for one million deaths in adult males between fifteen and fifty years of age there should be at least two millions constantly sick and the equivalent of fifty million admissions to hospitals'. The pandemic of influenza affected over 125 million and destroyed nearly thirteen million persons in 1918–19, and such an incredibly high death rate cannot be ascribed only to the unhygienic environment of its victims. Indian immigrants in Malaya, for example, were found to be more susceptible to infectious diseases than their fellow workers living practically under the same conditions.

Throughout India tuberculosis is on the increase. Year by year the official reports of the Departments of Public Health record an alarming increase in deaths from tuberculosis, in every province. The figures for Bengal in 1933 show an increase of 30·4 per cent; for Bombay over 35 per cent over the preceding year. The death rate from tuberculosis in Delhi is over 3 per 1,000 population. The women between 15 and 40 years are more readily susceptible to acute infection of tuberculosis than the men of the same age-group owing among other causes to early marriage and the *purdah* system. In all large centres of population the disease accounts for a high death rate as well as for the poor physique of those who have been 'uprooted' from a rural environment. The police recruits and labourers, drawn from villages, indeed, frequently become infected when they are faced with urban conditions of existence. But although its incidence particularly in its pulmonary form appears to be higher in the cities and towns than in the villages, there is every indication of its encroachment upon the rural areas. And once infection is introduced into the villages, Colonel Russell in his last Annual Report warns us, 'it is almost certain to spread

of the Buddhist periods; the monastic regulations show that only those who were physically strong could fulfil them and that the members of the Buddhist-Sangha were healthy and vigorous. In the pre-Buddhist era, the Aryan-speaking communities selected for service as priests, warriors, and traders only those 'who were not too young but of middle-age; who were brave, self-controlled, and able-bodied'.

Records of the early days of the British advent in India contain references to the excellent physique of the settled communities. Speaking of the natives of Bengal, the province where to-day the living millions of humanity present a ghastly picture of a race on the verge of collapse, Lord Minto at the beginning of the nineteenth century wrote: 'I never saw so handsome a race. They are much superior to the Madras people, whose forms I admired also. Those were slender; these are tall, muscular, athletic figures, perfectly shaped, and with the finest possible cast of countenance and features.' They were even enrolled in the British Army in India and fought well!

In the northern parts of India from where the Army recruits are drawn to-day, signs of physical deterioration among the fighting races cannot escape a discerning eye. 'There were many fine soldiers, well built and with stalwart figures; it seems to me that there has been a great change in the physique of the Indian peoples since that day.' So remarked the Gaekwar of Baroda, the other day in London while describing his impression of the Delhi Durbar of 1st January 1877.

While it is not our purpose to traverse here the entire field of public health in India, we feel justified in attempting a brief survey with a view of impressing upon the new Legislatures of India that if the task before them is of immense magnitude, the efforts to grapple with it must be of a similar calibre. The immensity of the task lies in the fact that the problem of public health is no longer related only to medico-hygienic activities by a group of specialists, but must take into consideration all the factors affecting the economic and social life of the community. Those who are now concerned with the task in the West realize that the problems of public health, of human and animal nutrition, and of agriculture which still remains even in the industrialized countries the basic industry, should 'vitally constitute the elements of a single great administrative

Wales from 1851 to 1920, he found 'a high inverse relationship between the *real* value of wages, and the tuberculosis death rate'. The potency of the economic factor in the incidence of this disease is shown so clearly by its ravages wherever the economic standard of life is low that the mortality from tuberculosis may be used 'almost as a mathematical function of a measure of poverty'. The rate increases considerably as one passes from the prosperous to the poor districts in any area. While poverty is not the only aetiological factor, it is becoming evident that there can be no other effective prophylaxis of this disease than the increase of the economic level of the people sunk to an abyss of misery. In other words, as Sir John Orr put it, 'the most effective line of attack on tuberculosis is by an improvement in diet'.

The problem of controlling the incidence of tuberculosis therefore requires not only an extensive organized campaign and adequate facilities for treatment, but a liberal provision of 'protective' foodstuffs, in order to increase the powers of resistance to the infection. Preventive medicine alone cannot solve the problem. It is a disease which spreads in a similar manner under various unrecognizable cloaks without assuming the proportion of an epidemic; and poverty and malnutrition are the two main factors responsible for its persistence among our ill-nourished population. 'It must be realized', writes the Public Health Commissioner, 'that the way to victory does not lie, except in small part, in the provision of clinics, hospitals, and sanatoria. Money spent on such institutions will be money largely wasted unless the social factors involved are studied and then attacked with vigour. In the practice of more hygienic methods of living, in the *provision of ample and nutritious food supplies** and generally in a wider appreciation of the dangers inherent in harmful social practices will be found the way to a gradual decrease of this scourge of civilization.'

As regards facilities for treatment, Major-General Bradfield, Director-General of the Indian Medical Service, informed the annual Conference of the National Association for the Prevention of Tuberculosis, in London (1938), that according to one authority there were about two million cases in India, but in the entire country there were only 77 clinics and 39 sanatoria.

* Italics are mine.

rapidly and to cause a heavy morbidity and mortality'. Accurate statistics of deaths due to various forms of tuberculosis in India are not available; nor can we, under the existing system of collecting vital statistics, have recourse to factual studies of any great significance. The death rate from tuberculosis is very often confused with multiple fevers and is recorded as such; and it was probably because of our defective system of recording vital statistics* that one of the leading physicians of Calcutta could declare at an International Congress in Berlin (1892) that phthisis and other lung diseases were rare among the natives of India!

In 1904 Sir Leonard Rogers, scrutinizing the death returns from a malarious tract of Bengal, obtained 'clear evidence that phthisis accounted for at least 9 per cent (90 per mille) of the total deaths in villages'. Recent public health reports of the province show an increase of over 30 per cent in the death rate from phthisis. Similar alarming facts reported from a great part of India confirm the view that the rapidity of the spread of this deadly disease is largely due to the very low resisting powers of its victims. And the root cause of low powers of resistance is, to quote Sir Leonard Rogers, 'that the stress of population is increasing to such an extent that there is not enough nourishment for the people'.

The mechanism of immunity to tuberculosis is not sufficiently clear; but it is known that resistance to infection is definitely influenced by proper nutrition and hygienic conditions of living. Recent investigations have proved beyond doubt that the spread of this fatal disease has a close relation to undernourishment and malnutrition. On examining the diet schedule of families where the disease has obtained a footing, it is noticed that their nutritional requirements are not being satisfied, especially with reference to 'protective' foodstuffs. Although the disease is not uncommon among the well-to-do classes, its rich field of harvest lies in poverty-stricken families. Ewart's study[39] on the relation between economics and tuberculosis shows that the effects of poverty upon the incidence of the disease are pronounced. Analysing conditions in England and

* ... but
... on,

stances are not normally metabolized and consequently there is an excess of sugar in the blood constantly percolating through the kidneys.

Hindus, whose diet consists of excessive carbohydrates and fats but is poor in proteins, are more suspectible to the disease than other Indian communities. Perhaps over-eating, one of the chief dietetic errors of the well-to-do Hindus, produces the metabolic disorders referred to above. Diabetes is frequently preceded by an acute form of dyspepsia. The diabetic symptoms usually occur between 40 and 50 years, and

The middle-classes can show no better record, and at the bottom of the 'health stratification' we have the agricultural and the growing industrial proletarian classes. Those who lament the rigidity of barriers between our various social groups should realize that one of the factors which can facilitate social mobility is the physical well-being especially of those belonging to the lowest social strata. The social promotion, for instance, of the *Harijans** cannot be attained merely by removing certain social disabilities from which they suffer. The temple-entry cannot arrest the tragedy of 'social sinking' if their health, physical and mental, is allowed to be undermined by poverty and defective nurture.

From our general description of the state of public health as

incidence of diabetes is worked out by a recent investigator as follows:

DIABETIC DEATH RATE PER 100,000 POPULATION

Countries	*Death rate*	*Percentage of Calories in the diet derived from fat*
Japan	2·9	4·7
Italy	8·2	18·2
Scotland	10·1	28·3
England and Wales	14·5	32·0
Holland	17·6	35·5
United States	20·4	36·1

(Himsworth, H. P., 'Diet and the Incidence of Diabetes Mellitus', *Clinical Science*, Vol. 2, 1935.)

* The *Harijan* refers to the so-called depressed classes. One of the social disabilities from which they suffer is that they are not permitted to worship in the orthodox Hindu temples. In recent years Mahatma Gandhi launched a movement for the removal of this restriction.

We have no organization for care of the convalescent or for rehabilitation of his economic position. Consequently even if he is cured of the disease, he is left in a wretched condition only to die of poverty.

There are other infectious diseases which have been successfully domesticated in India and owing to the diminished powers of resistance of her peoples they are able to take a heavy annual toll. Although sickness aggravates poverty and a high mortality rate is a pregnant source of waste, the seriousness of the state of public health in India lies in the prevalence of general debility among all classes of her population. In a resolution passed by the All-India Conference of Medical Research Workers, it is stated that 'the percentage loss of efficiency of the average person in India from preventible malnutrition and sickness is not less than 20 per cent'. What hope is there if the blessings of positive health are denied to the growing generation? How is India going to cope with the circumstances of the modern world if persistent ill-health hampers the life and labour of those who are called upon to share the responsibilities of India's economic and social welfare? For an adequate realization of the state of general health of all Indian communities, it is not altogether necessary to turn to statistical studies; the facts are well drawn on the physique of the people.

If one cares to examine the 'health stratification' of all the social groups in India, it would be evident that widespread ill-health is not confined to the poor. It is true that the upper social classes in India average a greater longevity and a lower mortality than the lower classes, but their general health is, with relatively few exceptions, poor and signs of their physical degeneration are becoming conspicuous.

Diabetes is prevalent among the upper classes of the Indian communities. It is observed that in some well-to-do Bengali families of Calcutta, most of the males 'have alimentary glycosuria or diabetes before reaching the age of fifty'. Here is a disease caused not by under-nourishment but through malnutrition leading to malassimilation of food. Probably a high percentage of carbohydrate and fat in the diet is one of the causative factors;* at any rate it is associated with certain disturbances in the metabolic process. Sugar and starchy sub-

* The correlation between a high percentage of fat in the diet and the

The provision of a safe water supply and the spread of knowledge about the grave risks attending the use of water rendered unwholesome by human or animal wastes is an essential condition for the physical well-being of our people. That contaminated water may well be a potent cause of malnutrition because of the gastro-intestinal disturbances frequently brought about by parasites introduced into the body through the drinking water, that water carries micro-organisms of certain infectious diseases which frequently break out in the form of epidemics, and that it also carries parasites responsible for diseases having their primary seat in the digestive tract—all these facts should be clearly elucidated before the public. Dysentery, both bacillary and amoebic, is a rural disease closely associated with the conditions of water supply in the village. In Eastern Bengal, Cunningham[40] found as high as 86·5 per cent of the dysentery cases under observation to be bacillary and came to a conclusion which is of special interest to a nutritionist. He believed that in a community where the infection is so widespread, one would discover several cases of latent dysentery among groups of apparently healthy persons. Then there is a host of water-borne diseases which year by year leave marks of debility upon the physique of our rural masses.

Sanitation

Our consideration of the state of public health in India would be incomplete without a reference to the problem of sanitary disposal of excretal matter and other filth which is closely related to the one we have just discussed. The dumping of night soil on the outskirts of our cities and towns is a common practice but it becomes a source of contamination of the sub-soil and consequently the use of water from wells is fraught with grave risks. Most of the dairies from which we draw our milk supply are situated near the sources of water into which there is a constant inflow of human and animal excreta. Even if the milk is not deliberately adulterated it becomes liable to contamination because of utilizing the contaminated water for washing the dairy vessels.

In most parts of our cities, the elementary form of conservancy persists; and there is no excuse why the sanitation in urban areas, where the demand for sanitary improvement has

reflected in the prevalence of disease and ill-health of the population, we now turn to the kind of environment which surrounds the lives of the Indian people. The spread of tuberculosis and the frequent recrudescence of infectious diseases point to an utter lack of essential sanitary amenities on which the health of a community so largely depends. Of these the supply of safe and ample water and the sanitary disposal of excretal matter are the two main items relevant to the subject of our discussion.

Water Supply

Water is an essential element of diet although it is neither an 'energy producer' nor a 'protective' food constituent. Among other reasons its indispensable rôle in all metabolic activities in the body makes water a prime necessity of life. The provision of water for drinking purposes as well as for domestic uses is therefore one of the elementary needs of a community.

Only in a small number of our towns and cities are there provisions for the supply of sufficient and safe water. In the rural areas, its supply comes from rivers, tanks, canals, and wells—which owing to the ignorance and indifference of the inhabitants in regard to the quality of the water they use, are liable to both contamination and pollution. The habit of performing their natural functions in water is common among the bulk of our rural population and the conviction that the water of the running stream cannot be defiled is deep-rooted. It is not an uncommon sight to see persons drinking water from the river only a few yards lower down while others are contaminating the same stream with human wastes. The habit of using streams for the disposal of human excreta may have arisen from the necessity of escaping from flies which inevitably collect round the land-latrine; or, it may be due to the empirical knowledge in regard to the evil effects of soil-pollution upon the health of the community.

We need not dwell here upon some of the extremely unpleasant details of the conditions of water-supply in rural areas in India. Village tanks or canals or cess-pools generally have the drainage waters of the village led into them; and the villagers, indifferent to all the sources of contamination and pollution, use the water for all purposes.

the Royal Commission on Indian labour an abominable state of affairs. In the crowded quarters the water supply is defective and so is the drainage, and it is not surprising that living in such an environment our working class is constantly afflicted with ill-health and disease.

Ten years have elapsed since the report of the Labour Commission was published; but no determined efforts have yet been made to cope with the appalling sanitary conditions in our industrial centres. There hovels multiply, overcrowding persists, tuberculosis and other allied diseases show an upward curve, the rate of infant mortality increases, and the physique of the working class drawn into the industrial centres for the meagrest livelihood deteriorates; but neither the city corporations nor municipalities nor the industrial enterprises have taken measures to improve the situation. In this respect Local Government authorities have indeed failed to discharge their duties, and in instances where industries have provided tenements for the worker, the lower income groups can have no access to them.

The environment of our labourers working in the mining areas is worse than that of industrial workers. Here a large proportion of the mining coolies are recruited from the aboriginal and backward tribes, who are obliged to resign themselves to whatever conditions of service are offered to them because they have no other means of livelihood. Their health and well-being must engage our immediate attention; for, to quote from those memorable words of Gandhi, 'if India is not to perish, we had better begin with the lowest rung of the ladder. If that was rotten, all work done at the top or at the intermediate rungs is bound ultimately to fail'.

As regards the sanitary conditions in rural areas, it is not an exaggeration to say that they bear no evidence of the administration of an advanced State claiming to be 'enlightened custodians of the health of the natives.'

Ten years ago the Government were persuaded to appoint a Royal Commission to inquire, for the first time, into the environment of over 300,000,000 living in rural India. Evidence of British medical men and public health officers before the commission was characterized by that sense of duty and devotion to their profession which no critics of the British

long been so insistent, should be of a very low standard. In Bombay, the home of the Indian cotton industry, there are still, for example, over 15,000 basket privies and the features of conservancy in other cities and towns are pretty much the same.

Here we may pause to consider the environment of our industrial workers. Within the last thirty years the extent of employment in industries has increased approximately by 148 per cent, but the figures conceal the actual trend of employment in various establishments. It is estimated that there are some 25 million workers who depend for their livelihood upon the total field of industries, but of these only 5 millions are employed in establishments of more than 10 employees; the average attendance of workers at factories of more than 20 workers employing power is about one and a half millions; and over two millions are employed under conditions which would normally be recognized in an industrialized Western country as constituting modern large-scale industry.

Drawn within the orbit of the industrial system, the millions of our workers find themselves in an environment worse than their village. Over 95 per cent of the houses occupied by our organized labour in industrial centres are unfit, even by an elementary standard of sanitation, for healthy human habitation. Mr. Sorley tells us in a recent report that some of the conditions of housing in Bombay city 'must be more reminiscent of the Black Hole of historical memory than of any modern city pretending to sanitary living conditions'. It is estimated that one-third of the population of 1,116,383 lives in rooms occupied by more than five persons at a time and 15,490 in rooms occupied by 20 or more persons. Here in the paradise of Indian capitalists over 97 per cent of the workers live in a single small room accommodating from 6 to 9 persons. 'The crowding on the floor space, the smoke and smells from the cooking; the food eaten amid a chaos of pots and pans; old clothes, bedding and crawling children; the heavy fetid air; the utter absence of privacy for ordinary needs as well as for birth, death, and sickness; the publicity of the common staircase, the common washing place, the common latrine, . . .' these are the constituent elements of housing in industrial India which, as Miss Margaret Read declares,[41] revealed to

advanced countries its incidence has been greatly reduced by the proper disposal of human excreta. So long as the hookworm disease retains its grip upon the masses of India no substantial improvement in their physique can be possible even through adequate nutrition; for, as Dr. Bentley, Director of Public Health in Bengal, says, it 'bequeathes a pernicious legacy to the infected community, its work being done in a subtle insidious manner, weakening the race generation after generation, always tending to produce a condition of physical, intellectual, economic, and moral degeneracy'.

As regards the direct relation between soil-pollution and purity of foodstuffs, one example may be cited here as an illustration of the seriousness of the situation. Beef is a common article of food of the Moslem community; but if the cattle are raised in an environment where the safe disposal of excreta is neglected and pollution of the soil with human faecal matter is widespread, the helminthic infections* render beef unfit for human consumption.

We trust that the emphasis which we have laid upon the subject of the environment of the people may not be considered irrelevant to the problem of nutrition; for physiologists have adduced adequate evidence to show that environment exerts a considerable influence upon the functioning of the mechanism of digestion. From this general account of public health in India, we now turn to specific instances of the conditions of health of infants, mothers, and schoolchildren.

Infant Mortality

Infant mortality is usually a sensitive index of the economic and sanitary conditions of a country. That it is extraordinarily high in India is an indication not merely of the state of public health but of a vast source of misery and waste. Apart from other considerations, the high infant mortality puts a severe strain upon the precarious economic life of the family; and its tragic repercussions upon the health and mental outlook of the child-mother cannot be estimated so long as she remains a voiceless victim of both social and economic circumstances.

* In this instance the infection is caused by the cysticerci of a kind of worm (*Taenia saginata*) found in human faecal matter.

administration could deny. They were keenly interested in every aspect of the problem of rural India that appertains to the health of the people and regretted, as Ross once observed, that for the purposes of sanitation and public health they received 'only the crumbs which remained at the bottom of the public pocket'.* And the Report of the Linlithgow Commission observed: 'Sanitation, in any accepted sense of the word, is practically non-existent. The public latrine is too often the bank of the river or the margin of a tank. This predisposes to hookworm infestation and to the spread of the diseases caused by a polluted water supply, for the same water is in many places used both for drinking and bathing purposes. Unprotected wells and tanks, unswept village streets, close pent-up windows excluding all ventilation; it is in such conditions that the average villager lives. . . .'

The lack of provision for public water supply and the unhygienic ways of disposing of human excreta are the main factors which have made our rural areas a veritable slum; and not only the application of the principles of preventive medicine but the maintenance of an effective standard of health and physique has become an impossibility in that environment.

Widespread pollution of the soil is responsible for helminthic diseases and for the frequent outbreak of epidemics. The hookworm, a parasite (*Ankylostoma duodenale*) which causes so many depressing symptoms of ill-health, still continues to infect the greater part of India. Nearly 80 per cent of our rural population suffer from hookworm disease† (*Ankylostomiasis*), which is perhaps one of the most common tropical diseases. The prevalence of anaemia among tea-garden coolies and agricultural labourers is partly due to hookworm infection. Add to this malaria and chronic undernourishment, and you have the picture of the state of health of our labouring class.

Although hookworm disease has existed for centuries, the discovery of the causative factor by Dubini in 1883 has shown that its incidence can be prevented by taking adequate measures to stop the pollution of the soil. And in some of the [illegible]

[illegible] about 1550 B.C.

1929 in the fair cities of Madras, Madura, Coimbatore, and Trichinopoly showed as follows:

Income per month (rupees)	*Death per mille*
25 and under	120
50 and under	102
Over 50	84

But, let us admit that the social custom which encourages immature maternity is also responsible for this senseless slaughter of the innocent. Nearly 40 per cent of Indian girls are married at about the age of 15 years. The conditions under which they bear children, the environment under which they live and their insufficient and defective diet are some of the contributory factors not only to the progressive loss of their vitality but to the short span of life of our population. An estimate of survivors of 100,000 infants at the end of 50 years shows that India has the lowest number in comparison with England and Japan.

TABLE V*

Survivors of 100,000 Infants at the End of Fifty Years

Countries	*Male*	*Female*
England	59,903	64,742
Japan	52,629	51,794
India	18,658	19,714

Whatever may be the root cause of this low survival value of our population, the outstanding factor is certainly the prevalence of under-nourishment and malnutrition among infants from the age of 2 to 5. No other age-groups of our population suffer more from malnutrition. It is not surprising that the rate of infant mortality should be so high when a large proportion of babies receive nothing better than rice-water or other forms of gruel. It is therefore imperative that special provision should be made for the supply of fresh milk or milk-powder to infants. The establishment of a number of dairy farms throughout the country for this specific purpose would be a useful measure to be undertaken by the State; and in factories and industrial centres where women are employed the supply of milk to their children should be compulsory.

* Taken from *Child Marriage* by Miss Eleanor Rathbone, M.P.

The rate of infant mortality is, of course, related to various factors such as age of mother, her general health and nutrition, adequate intervals between childbirths, income of the family, and the kind of environment. In urban areas and industrial centres, the lack of housing accommodation bears a direct relation to infant mortality. The statistics of Bombay, for example, show that the rate varies in direct proportion to the number of rooms in the houses occupied by the labouring classes. But the prevention of diseases in infancy depends more upon diet than upon any other single factor. Medical authorities consider that the pre-natal period is probably the most important period in man's existence and that the development of various diseases may be traced to a defective state of pre-natal nutrition.

Two main diseases which are responsible for the loss of over one-fifth of the Indian infants born in the first year of life, are disorders of the alimentary system and respiratory diseases. We have now ample evidence to show that one of the chief causative factors in the prevalence of these ailments may be traced to defective nurture. It is estimated that over 75 per cent of infants under two years develop anaemia and that the anaemic infants are liable to fall victims to both gastro-intestinal troubles and respiratory diseases.

No serious attempts have been made to estimate the extent of infant mortality in British India and the figures available vary, for example, between 137·8 in Bihar and Orissa to 329 in Lucknow. In Calcutta the average death rate is 278 per thousand births in the first month of life; but in the Jute Mill areas the figure is as high as 282. At any rate, no one can dispute the fact that the infant mortality both in urban and rural areas throughout India remains obstinately high and that its causative factors must be fully investigated.*

The unimaginable poverty of the people is of course one of the main causes of this abnormally high rate of infant mortality in India. It is higher among families belonging to the low income groups and the rate decreases with a general improvement in the standard of living. An investigation initiated by the Director of Public Health in the Presidency of Madras in

* Infant mortality in New Zealand 34, Canada 94, Japan 140, and India 187 per 1,000 births.

Wills and Mehta[43] conclude from their investigations that the high maternal mortality in India may be ascribed to the severity of pregnancy anaemia which is largely nutritional in origin. Its incidence is particularly high among the working class. In 31 tea-gardens in Assam, Balfour[44] found on examining 9,373 deliveries registered within a period of three years that an average maternal mortality was 42 per 1,000 and that in one garden the rate was as high as 130. Taking the data for *the year 1932 alone, the death-rate revealed the appalling* figure of 256 per 1,000. There is every reason to believe that a great percentage of this heavy mortality is due to pregnancy anaemia.

It should be noted that anaemia usually occurs in those patients who have had for a considerable time a diet deficient in such essential food constituents as proteins, calcium, iron, *and vitamins.* And, *since the foetus 'is a parasite who robs the* mother' of these nutrients, their supply should be well assured in the maternal diet. The diet should therefore contain an adequate quantity of 'protective' food constituents supplied by milk, milk-products, *fresh* green vegetables, eggs, and fish.

There are other grave symptoms of ill-health in this period of woman's life which may be traced to undernourishment and malnutrition. Eclampsia before or during labour, is sometimes due to chronic deficiencies of vitamins and inorganic substances. Theobald[45] has recently suggested that all forms of toxaemias of pregnancy may be regarded as the consequences of dietetic deficiencies, especially if there be any disturbance in calcium metabolism. Based upon his observations in India, Green-Armytage found that tetany 'is much more common than is realized and may be seen in women in all communities during pregnancy, if their diet is defective and they are anaemic'.

It should be understood that the high maternal mortality in India is not merely a question of poverty. Inadequate and crude maternity service, ignorance in regard to proper and adequate nutrition, adherence to harmful social customs and depressing environmental conditions—all these circumstances combine to produce so much suffering in almost every home in India. 'Twenty-five years experience of pregnancy conditions in every community has convinced me', writes Green-Army-

Mothers of 'Mother India'

All medical evidence tends to show that nutrition is at the bottom of the problem of maternal mortality. In pregnancy there is an increased demand upon the supply of essential food constituents necessary for the growth of the foetus as well as for the maintenance of strength of the expectant mother. In the period of stress and strain, her health and nutrition are almost synonymous. It is largely due to the pronounced deficiencies in diet that the maternal mortality rate in British India ranges as high as 55 per thousand live births. A statistical analysis from the records of the Calcutta Eden Hospital for the period 1850–1901 shows that the death-rate at delivery was 66·5 per *mille*[42]. It is not possible to obtain an *accurate* All-India estimate of maternal deaths on account of the defective system of collecting vital statistics but medical authorities believe that deaths in childbirth exceed 200,000 per annum.* An examination of maternity statistics from the State of Mysore shows that over 55 per cent of maternal deaths are associated with still-births and that they are more frequent among the Hindu communities.

It is a truism to say that irreparable damage is done to the childbearing woman by undernourishment and malnutrition. 'After all, sound nutrition in a pregnant woman', writes Sir George Newman in his report (1933) to the Ministry of Health of the United Kingdom, 'is obviously the only way of sustaining her own health and strength and that of her forthcoming child. She should become accustomed to a diet which includes ample milk (two pints a day), cheese, butter, eggs, fish, liver, and vegetables, which will supply her body with essential elements, salts and vitamins, without overburdening the organs of excretion.'

Figures, calculations, and neatly recorded tables, etc., are not available to show the state of nutrition of Indian child-mothers; but in support of the fact that it is inadequate and faulty, we have only to look within our homes where for every 1,000 babies born over 350 mothers become disabled, and about 24 die; nearly 2 per cent of all pregnant women in India suffer from pernicious anaemia.

* For figures in some other countries of the world, see Appendix I.

much-vaunted glories of Indian motherhood should realize that the failure to provide adequate and proper maternal diet is one of the root causes of racial decay.

Health of Schoolchildren

Records of attendance of pupils both in primary and secondary schools in India show that a large percentage of absence is due to illness; but owing to haphazard and spasmodic medical inspections it is difficult to ascertain the nature of the illnesses or the extent to which they may be ascribed to undernourishment and malnutrition. Nevertheless, Sir Ronald Ross's mordant picture of a class of Indian pupils, 'all with enlarged spleens, struggling to learn by rote the dates of accession of the Plantagenet Kings', is pathetic but true. Lack of muscular tone, roughness of skin, tired eyes, slow gait—all these are well marked in most of our schoolchildren. Nervous restlessness, poor comprehension, poor memory, and the habit of lisping are the symptoms which indicate a certain retardation in the processes of co-ordination of the nervous system.

A system of medical inspection in India other than seeing the schoolchildren 'on parade' has revealed some of the common defects arising from prolonged suboptimal nutrition. A closer examination, for example, of the pupils in secondary schools in Bihar and Orissa in 1932 showed that 62 per cent of the boys and 66 per cent of the girls examined had some pronounced defects which could be ascribed to nutritional deficiency. Among nearly 1,500 children in the primary schools in Central Provinces, over 33 per cent suffered from rickets, faulty dentition, dental caries, and various forms of gastro-intestinal disorders. Nearly 30 per cent of the children examined in the North-West Frontier Province suffer from dental diseases. Investigations recently conducted by Aykroyd and his associates into the state of nutrition of schoolchildren in South India show[46] the heavy incidence of angular stomatitis, phrynoderma, and Bitot's spots among them, the frequency of which is related to the insufficiency of 'protective' foods.

The prevalence of these specific symptoms associated with undernourishment and malnutrition is coming more and more under the close observation of the medical profession and Public

tage after his prolonged sojourn in India, 'that diet and sunlight deficiency are responsible for an ever-increasing number of obstetrical difficulties.' In a country where the fate of every girl, irrespective of her physical and mental condition, is marriage, it is not surprising that only a small percentage of Indian women are aware of the joy of good health.

A vast number of mothers survive the ordeal of childbirth only to live a life of chronic invalidism, the dire consequence of which is reflected both upon the family and the community. It is this depressing fact which is largely responsible for the persistent gloom that overshadows the Indian home. Not only does it involve individual suffering but is also a severe strain upon domestic economy.

Then there is the custom of *early* marriage. How it affects mother and child is shown in great detail in the Report of the Age of Consent Committee appointed by the Indian Legislative Assembly in 1928. That a fairly large percentage of our child-wives die of some form of respiratory disease or of some ovarian complication within ten years of the consummation of marriage, that the maternal mortality rate at ages from 15 to 19 is nearly 50 per cent lower than the rate below the age of 15, that still-births and neo-natal deaths are frequent in the case of mothers below 16—all this is emphasized in the report. It says: 'Early maternity is an evil and an evil of great magnitude. It contributes very largely to maternal and infantile mortality, in many cases wrecks the physical system of the girl and generally leads to degeneracy in the physique of the race. . . . The evil is so insidious in all its manifold aspects of social life that people have ceased to think of its shocking effects on the whole social fabric.' Sir John Megaw estimates that 'one hundred out of every 1,000 girl-wives are doomed to die in childbirth'. Indeed, the mothers of 'mother India' oscillate between two conditions of existence, namely, gestation and lactation, till merciful death comes to their rescue.

While the serious consequences of premature motherhood as a dysgenic force should be brought home to the people, the problem of nourishment during pregnancy and lactation is urgent and measures of direct assistance, where necessary, have to be adopted in order to protect mothers against the risks of malnutrition. Those who are loud in proclaiming the

nutrition operating for long periods of time among all sections of the population of India have not as yet been undertaken, we hope to be able to adduce sufficient evidence from the observations of medical officers in India to elucidate the fact that there are several diseases prevalent in the country in which the main aetiological factor is concerned with the constitution of the dietary. It must, however, be remembered that there exist a large number of border-line cases which do not show clinically recognizable symptoms of deficiency disease; nevertheless they are there to undermine the stamina of the people. In Indian homes, rich or poor, the complaints of suffering from undefinable illnesses are almost universal and their occurrence may also be traced to the imperfect state of metabolism, resulting chiefly from inadequate or improper diets. Intestinal stasis, chronic constipation, dyspepsia, and other forms of ailments arise mainly from disturbed metabolism. Diabetes mellitus, as already mentioned, is another disease caused by disharmony in the metabolic process, especially in relation to carbohydrate and fat. Beri-beri, rickets, osteomalacia, ophthalmic disease, and various forms of anaemia are common in India.

Gastro-Intestinal Disorders

There is a common saying with us that 'man is an organism built around a food tube'. Our unsophisticated folk regard health of the body as mainly dependent upon the proper functioning of the gastro-intestinal tract, which, they have observed, suffers most from irregular diet. Gastric and duodenal ulcers, colitis and various types of gastro-intestinal disturbances are due to faulty nutrition, or to dietetic errors. That an important relation exists between food accessories and the normal functions of the gastro-intestinal tract has been clearly demonstrated by McCarrison.[47] He selected two kinds of diets to feed albino rats, one resembling the usual diet taken by the poorer class of population in Madras, and the other by the indigent peoples of the State of Travancore. Both these diets were grossly deficient in vitamin content as well as in other essential food constituents. Among the first group of his animals there was an incidence of gastric ulcer of 11 per cent and in the second group 28 per cent.

Health authorities and the problem of defective nurture in childhood has become a serious concern of every civilized state.

The Mixed Committee on Nutrition of the League of Nations found that a decline in physique was specially common among undernourished children between the ages of 15 and 18 and that between those ages the risk of pulmonary diseases is generally great. In the absence of an organized system of medical inspection of schoolchildren in India, we do not realize the extent of wastage involved in providing educational facilities to those who are sadly handicapped with ill-health and cannot benefit from education. There is, therefore, ample justification for the resolution recently passed by the All-India Women's Conference that 'Systematic medical inspection should be made compulsory in all schools and colleges; and in the case of girls, the inspection should be carried out by medical women. Where possible school kitchens should be started and arrangements made to deal with cases of malnutrition'. Results of such medical inspections, especially in regard to evidence of undernourishment and malnutrition, should be widely circulated both on the grounds of awakening social conscience and in furtherance of the spread of the 'new knowledge of nutrition'.

In Chapter Seven we have attempted a short account of the measures adopted by certain advanced countries for the supervision of the nutrition of schoolchildren. We now pass on to a general survey of some of the common food-deficiency diseases in India.

Prevalence of Diseases Caused by Nutritional Deficiencies

In Chapter Three we have collated some general information in regard to the consequences of multiple and partial dietetic deficiencies. Here our purpose is to deal with certain pronounced manifestations of diseases in India, apart from several obscure illnesses, which are closely associated with a lack of essential food constituents and food accessories. While systematic investigations into the nature and extent of functional disturbances caused by undernourishment or by mal-

milled rice stored under conditions altogether unfavourable for its protection against moisture and heat; and it disappears with the harvest of the new rice crop. A liberal supply of protein and the substitution of wheat for rice are recommended for the treatment of the disease.

Epidemic dropsy has certain symptoms which often confuse the disease with beri-beri, but aetiologically they are not related; though 'there is little doubt that rice dietary plays a very important role in their aetiologies'. We have already stated some of the characteristic features of beri-beri, which is more widespread in India than is usually supposed. It occurs in Bengal, Bihar, Assam, Madras, and Malabar—the areas where rice is the staple diet of the people. Although its outbreak is primarily associated with the consumption of milled rice because of the loss of vitamin B in the milling process, it is held that a pronounced deficiency of vitamin A may have an ancillary action. It may thus explain why Indian labourers, whose diet consists of milled rice of inferior quality and is almost devoid of the sources of vitamin A, suffer most from beri-beri. It should be noted here that an ill-balanced diet involving deficiencies of proteins and inorganic salts but containing an excessive amount of carbohydrates often leads to the development of symptoms somewhat similar to those of beri-beri.

But the salient deficiency of vitamin B1 is the chief aetiological factor in the incidence of this disease and therefore our attention must be drawn to measures that can be taken to control the production of over-milled rice. The husk of rice-grains is removed by two processes. One is to soak it for some time and then to steam or boil it. After drying the paddy thus treated, either in the sun or in heated cylinders, it is pounded or milled. The process is known as parboiling. The other process is just milling without these preliminary treatments of soaking or steaming.

The relation between various grades of milled rice and the incidence of beri-beri may be seen from the following table composed from data obtained by Vorderman in his examination of over 279,000 persons in the prisons of Java and Madura.

Medical authorities are agreed that when gastro-intestinal disturbances become associated with nervous disorders, various forms of neuritic symptoms soon manifest themselves and that this association is also due to nutritional deficiencies.

Nervous Disorders

Inadequate diet with the total calories below 1,000 and pronounced deficiency in 'good' proteins, fats and vitamins gives rise to some of the characteristic features of the disease known as famine dropsy. Although its name suggests association with famine conditions, it should not be concluded that the disease breaks out only when the Government decide to declare famine! It is strikingly a disease of poverty. Signs and symptoms—such as weakness of the muscles, emaciated body—are noticeable among our indigent population throughout India; but only when they are allowed to develop to a great extent does oedema of the body set in and the victim become incapacitated. Infants fed largely on a starchy diet over a long period are liable to the disease, and it is rather widespread among schoolchildren. Sir John Megaw rightly says, 'Minor degrees of this disease are common among people living on the border-line of starvation.' A picture of famished India would abundantly corroborate this statement.

There is another form of dropsy not strictly regarded as a deficiency disease which breaks out as an epidemic, especially among people whose staple diet consists chiefly of rice. Its incidence appears to be related to the use of parboiled, highly polished rice, especially if the cereal is stored for considerable periods in damp places. Megaw, Acton, Chopra, and other authorities consider that epidemic dropsy is caused by the toxins produced in rice by micro-organisms* under improper conditions of storage; and their observations in Calcutta are confirmed by Burnet in his investigation of the incidence of the disease in Sierra Leone. It is believed that rice toxin also destroys vitamin B complex. The study of the epidemic in rice-growing tracts in India shows that it usually breaks out among the communities which depend for their supply of grain on

* An organism named *Bacillus asthenogenes* is found in badly stored rice and may be a causative factor in the production of a toxin in the digestive tract.

pleasant taste and that it does not keep as long as milled rice, that a reliable test for distinguishing rice that contains enough vitamin B1 from rice that does not had not yet been found, and, finally, that 'the prohibition of highly milled rice in Far Eastern countries would meet with great resistance from the rice trade, which, in general, is organized to produce that article'.

The speciousness of the first three of these 'reasons' is clear when one remembers the official declaration of the Far Eastern Association that, 'there is enormous annual loss of life, with corresponding invalidism and disability, due to deficient diet in the above countries (the Far Eastern countries) and this deficiency is mainly due to the over-milling of rice, which removes a vital part of the essential food factors . . . nothing has been put forward in the last ten years which proves that beri-beri cannot be controlled by substituting under-milled for polished rice in countries in which rice is the staple article of diet.'

It therefore appears that the real reason for the Governments' refusing to take action is the opposition of the rice manufacturers, who do not wish to be forced to reorganize their industry. The anomalous situation thus created is well illustrated in Siam where unmilled rice cannot be purchased but where the Government buys the rice-polishings from the manufacturers and makes vitamin B1 extract as a cure for the beri-beri which is rife in the country. Thus the manufacturers are both saved from having to reorganize their industry and paid by the Government for their waste product out of the taxes of those who suffer from beri-beri as a result of the manufacturers' recalcitrance. Aykroyd rightly stigmatizes this situation as 'roundabout, inefficient, insane'.

The provinces in India where beri-beri is increasing with the use of milled rice should follow the example of the Government of Federated Malay States by prohibiting the use of polished rice in all institutions directly under the State control, such as schools, hospitals, asylums, and jails. Ever since that Government enforced the measure in Singapore, there has been a steady decrease in the incidence of beri-beri, and the people are beginning to realize that the substitution of undermilled for milled rice is a step towards the maintenance of

TABLE VI*

Beri-Beri and Milled Rice

Type of Rice Consumed	*Number of Prisons Examined*	*Number in which Beri-beri Occurred*	*Per Cent*	*Proportion of Cases of Beri-beri Among Total Number of Inmates*
Half-polished	37	1	2·7	1 in 10,000
One-third polished	13	6	46	1 in 416
Polished	51	36	71	1 in 39

In the provinces where rice is a staple food, steps should be taken to adopt measures for proper storage of the cereal. In India the medical authorities have drawn the attention of the Government to the importance of stamping out both beri-beri and epidemic dropsy but nothing has yet been done. 'These diseases are so serious', writes the *Indian Medical Gazette*, 'they are responsible for such an immense amount of mortality and morbidity, and their prevention appears to be such a simple matter, that Governments of the countries affected might well consider the advisability of formulating regulations for ensuring the proper storing of rice, and for restricting the sale of diseased grain.'

The chief obstacles in the way of eradicating it are, as is always the case with deficiency diseases, poverty, ignorance, and deplorable economic conditions. The wretchedly penurious populations of the East are as a whole too poor and too ignorant to have a diet sufficiently varied to prevent beri-beri. But the obstacle of poverty and ignorance might in this case be easily overcome by prohibiting the manufacture of highly milled rice and so forcing people to consume rice that contains enough vitamin B1. The Far Eastern Association of Tropical Medicine did indeed propose such a prohibition as long ago as 1921, but the official representatives of the Governments concerned refused in 1923 to take any action on grounds that one might call frivolous if they did not conceal a turpitudinous purpose. These persons declared that the aetiology of beri-beri was still not fully elucidated, that unmilled rice has an un-

* Based on the table in the Medical Research Council's Report on the Present State of Knowledge of Accessory Food Factors, 1924.



III. Typical appearance of angular stomatitis in a girl aged 20.
By kind permission of Dr. W. R. Ackroyd.



IV. A closer view of rickets.
By kind permission of Miss A. Edgar.

health. The need of proper rice-storage as an insurance against the outbreak of dropsy and allied disabilities is equally urgent, if the health of rice-eating peoples is to be protected. With the introduction of rice-mills, the storage of rice in the form of paddy and the practice of unhusking small quantities at a time as required are not in favour, especially in the urban areas. Public institutions, industrial communities, organized boarding-houses, and other bodies concerned in mass-feeding should take adequate care for the storage of rice; and municipal organizations should be empowered to supervise the methods of storage adopted by grocers and rice-dealers. The period of storage should be as short as possible. As regards the rural areas, the encroachment of rice-mills should be discouraged, and the indigenous organization known as 'Dharma gola' can be revived, through efforts of co-operative societies.

Lathyrism is a form of chronic nervous disease associated with 'degenerative changes in the spinal cord similar to those occurring in dogs fed on diets deficient in vitamin A'. But its incidence appears to be closely related to the habitual use of the seeds of certain species of vetches (e.g. *Lathyrus sativus, Lathyrus cicera, Vicia sativa*) although the precise nature of the correlation between their consumption and the symptoms of the disease is not as yet clearly elucidated; but since the symptoms are somewhat similar to those of food intoxication by a toxic alkaloid substance, it was suspected that the vetches referred to above might contain poisonous substances capable of causing the disease. But, 'it is possible', writes Megaw, 'that the absence of vitamin A and carotene from the diet allows a neurotoxin in the peas to exert its harmful effects on the central nervous system'.

Rickets and Osteomalacia

The causative factors of both these diseases are identical. While a pronounced form of rickets is common in some parts of south and western India, minor degrees of its symptoms occur wherever the diet is deficient in vitamin D. Rickets is common among infants and children, and osteomalacia occurs chiefly among female adults. Infants who cannot obtain the mother's milk and are ill-fed, develop symptoms of rickets; or in consequence of an inadequate supply of calcium and phos-

[illegible] of the [illegible] pregnancy [illegible], perhaps [illegible] [illegible] and [illegible] may be present, and [illegible] [illegible] be extremely def[illegible] the infant may [illegible] the disease. On the other hand, there is [illegible] [illegible] to them that a prolonged [illegible] [illegible] by a period of proper diet. In the Kangra among the people whose diets are quantitatively and highly deficient and contain an excess of cereals, We [illegible] the greatest incidence of both rickets and osteomalacia; Gurkhas, whose dietary includes milk, vegetables, and animal origin, are relatively free from these diseases. [illegible] weakness, tenderness, muscular spasms, pains in the [illegible] are some of the early symptoms of osteomalacia. If [illegible] unchecked softening of the pelvic bones sets in and pregnancy they become deformed. It is found that the [illegible] is frequently preceded by pregnancy anaemia.

[illegible] its geographical distribution, it is of frequent [illegible] in Northern India and in the province of Bombay. [illegible] comparatively rare in Madras and in the Gangetic delta. [illegible] rickets and osteomalacia are fairly common among the [illegible] in the Central Provinces. Balfour[11] found that the average [illegible] of osteomalacia in Indian hospitals was 2·4 per [illegible] maternity cases, while the ratio per community per 1,000 [illegible] was as follows, for All-India excluding Bombay.

	Ratio per 1,000 labours
Hindus	3·0
Mohammedans	6·0
Others (mainly Christians)	5·2

[illegible] purdah is strictly observed among Mohammedan women [illegible] Bombay, the ratio of the disease among them per 1,000 [illegible] is as high as 38·0. The disease is prevalent in the State [illegible] Kashmir. Dr. Kathleen Vaughan[10] reports that out of 29 [illegible] caesarian sections performed by her during her first year as a [illegible] medical officer of the State Hospital, at least 25 were due to [illegible] the deformity caused by this distressing disease.

[illegible] Most investigators are agreed that the development of osteo[illegible] malacia is contingent upon at least one additional factor be[illegible] [illegible] deficiencies in diet, namely, unhygienic conditions



V. Rickets, which cripples Indian children by the thousand.
By kind permission of Miss A. Edgar.





VI. Xerophthalmia, an eye trouble caused by deficiency of vitamin A. The cause of thousands of cases of blindness annually in India.
By kind permission of Professor C. E. Bloch.

of living, especially want of sunlight and fresh air. We have already alluded to the custom of purdah which debars young girls approaching the age of puberty from the blessings of the open-air life. Where the evil of purdah and the dire poverty of the people conspire, the disease finds favourable circumstances for tightening its grip, but the fact that the disease frequently occurs among the wealthy communities such as the Banias, Marwaris, Bohras, and Khojas, who strictly adhere to purdah precludes it from being associated with poverty alone. Here unbalanced dietary is responsible, but the incidence of the disease among the poverty-stricken peoples who do not observe the custom shows that sunlight cannot prevent osteomalacia if the diet is grossly deficient in essential food accessories. The main factor in the aetiology of the disease is a consistent lack of vitamin D, together with excessive use of cereals. Wilson's[51] observation in the village of Launa in the Punjab confirms that the influence of diet in the incidence of osteomalacia is predominant. All the inhabitants of the village live freely in the open air, and sunshine is plentiful eight months of the year; and yet, 'of the three groups in the village, those living on cereals and practically without milk, eggs, greens, or meat showed a heavy incidence; those better off and having a little milk and perhaps a slightly better diet, a milder incidence; those having milk, occasionally fresh greens and fruit, and more cooked vegetables and meat, showed no signs of the disease'.

We have already mentioned that there is a general agreement among medical authorities that certain forms of dental diseases such as caries are primarily due to inadequate *protective foods*. Defective calcification of the enamel and dentine of the teeth and consequently low resistance to caries are now ascribed to marked and prolonged dietary deficiencies, especially in the supply of calcium and vitamin D. Pyorrhœa alveolaris is also associated with a diet deficient in vitamin A. Megaw observes that 'Caries in young Indian adults is far less common than in England or New Zealand. Pyorrhœa alveolaris on the other hand is almost universal after the age of 40.' Clinical experience shows that well-balanced diets definitely arrest the progress of tooth decay.

Statistics of the prevalence of dental diseases in India are not

available but even the cursory medical inspections carried out in schools reveal that they are common even in those parts of the country where diets are comparatively satisfactory. In the North-Western Frontier Province, for example, over 30 per cent of the schoolchildren suffer from dental caries and other forms of dental diseases. Among the population in the rice-growing parts of India, the incidence of badly formed or decayed teeth is widespread. Many children who may have an outward appearance of good teeth are found on examination to need dental treatment.

Eye Diseases

The association of dietary deficiencies with certain diseases of the eye has long been suspected, and sufficient data are being collected by medical investigators to correlate the relationship on an accurate basis. It is admitted that even where the specific effect of vitamin deficiency may not be ascertained, its indirect influence upon the health of tissues or of membranes is often pronounced; and that malnutrition and consequent low vitality may be one of the important causative factors in retinal defects.

The inflammation of the eyes so common in India among women and children is largely due to the inadequacy of vitamin A, along with other co-existing deficiencies, in their usual diet. In many cases there is an almost complete inhibition of the activity of the lachrymal glands and the persistence of the symptoms often leads to blindness. Defective vision, dryness of the conjunctiva, and other signs of eye diseases are noticeable among a large proportion of schoolchildren in India, the chief cause of which is malnutrition. Those who are familiar with our rural folk cannot but observe cases of keratomalacia among the poor classes. It is common on the tea plantations of Assam and elsewhere, and also among the industrial workers. Medical authorities believe that keratomalacia is responsible for more blindness among children in many parts of India than any other eye disease. We are indebted to Lieut.-Colonel Wright for his vivid description of the symptoms of this disease in South India, where he observed the fatal consequences of prolonged vitamin A deficiency. He[52] says: 'When the early signs and symptoms appear, if nothing is done to augment the

successfully checked by ensuring adequate supplies of vitamins A and D.

Skin Diseases

One of the conspicuous manifestations of dietary deficiencies is to be found in the prevalence of skin diseases. We have already mentioned pellagra, which is, according to Aykroyd, 'the most horrible of all food deficiency diseases'. The disease is not uncommon among the indigent population of North Bihar, Hyderabad (Deccan), and certain parts of the Presidency of Madras. It prevails mostly among agricultural labourers whose diet is utterly deficient in proteins and vitamins.

In various other forms the symptoms of unhealthy skin prevail to a great extent among our ill-nourished population. According to a recent investigation by Aykroyd and Krishnan[53] a type of stomatitis (sore mouth) somewhat similar to that found in pellagra patients is common among poor children in the Presidency of Madras. What is described as toad-skin (phrynoderma) is due to vitamin A deficiency, and the subject whose skin is thus affected is often afflicted with sore mouth. It has also been noted that pathological conditions of the skin are frequently associated with keratomalacia.

The progressive wasting of the child suffering from malnutrition is usually manifested in the condition of the skin. Describing the clinical aspect of the cases of vitamin A deficiency, Wright observes that 'by the time the average mother brings the baby to hospital, the skin is hanging in baggy wrinkles round the joints—the so-called elephant skin—the mucuous membranes of the mouth, nose, and throat are wasted, glazed and dry, the thin piping or hoarse croaking voice is hardly recognizable as proceeding from a human being'.

Stone in the Bladder

The formation of stone in the bladder (urinary calculi) is a common disease in the western part of the United Provinces, the Punjab, Sind, and the North-Western Frontier Province. McCarrison's researches show[54] that a pronounced deficiency of fat-soluble vitamin A and an imperfect balance between the supply of calcium and phosphates in the diet are the two fac-

amount of essential food-factors in the diet, the case rapidly progresses and marasmus sets in; the patient becomes wasted, the skin harsh and earthy-looking, the hair appears dull, brittle and thin, the mucous membranes also show a diminished secretion and the more accessible membranes of the nose, throat and mouth are seen to be abnormally dry. It is generally somewhere about this stage that babies are brought to the out-patient department. *Pari passu* with the wasting of the mucous membranes, there is an advance in the eye symptoms. As a rule, the smoky conjunctiva becomes dry, wrinkled, and greasy-looking, the cornea becomes dull and lustreless and eventually opaque. . . . Later the cornea undergoes necrosis and ulceration, and if untreated, the ulcer perforates, and the eye is ultimately lost.'

There are no statistics of the blind for India, but it is estimated that there are about one and a half million totally and over four million partially blind persons. Night-blindness is common among our poverty-stricken adult population. The incidence of eye diseases varies in different parts of India according to the state of nutrition and to the acuteness of poverty of the masses; consequently the estimated figures for total blindness show a variation of from 450 to 900 per 100,000 persons.*

In recent years a number of institutions have come to be established in India for social amelioration and training for the blind; but a greater emphasis should be laid on the prevention of the contributing causes of blindness—one of which is undernourishment and malnutrition. The prevailing belief among our peoples that blindness is a form of punishment for misdeeds committed in a former existence has to be refuted by demonstrating how defective vision and retinal defects are related to the diet. When supplied with diets which include adequate milk and butter or when treated with liberal doses of cod-liver oil, retinal defects at their initial stage are remedied. Certain types of conjunctivitis prevalent among Japanese school-children were successfully treated by the use of various oils containing vitamins. In Central Europe during the period following the Great War, the prevalence of night-blindness was

* The figures for totally blind in Egypt are 1,219, England and Wales 119, Japan 105, United States 49, and Belgium 36 per 100,000 of the population.

dices of the general population and lack of initiative among them to attaining a high standard of sanitation added to the complexities of the problem. Nevertheless, imbued with the spirit of science, they pursued their goal with zeal and enthusiasm. They were not sceptical of their success in overcoming the initial difficulties which faced them; nor did they lay undue stress upon the conservative forces within the Indian socio-religious system as being hostile to the benefits of medical science and hygienic practice. They knew that most of the scourges which now afflict India had once upon a time existed in Europe and bred among her peoples that fatalistic attitude and superstitious bent of mind which to-day undoubtedly darken the outlook of the Indian masses; they frankly acknowledged that a satisfactory advance in matters relating to public health and hygiene could be made possible if the Government took adequate steps for providing facilities for medical education; and they found the progressive elements in Indian communities responsive to measures for the physical welfare of the peoples.

In the third decade of the nineteenth century, they took the initiative by establishing a medical college in Calcutta for training the Indian youth in medical science and hygiene and found in them promising material for acquiring the knowledge of medical relief and sanitation. 'Difficulties will beset his progress, it is true,' wrote Dr. O'Shaughnessy, a teacher of chemistry and pharmacology in the Calcutta Medical College in 1844, 'but to overcome them all, he requires only the qualities which the Indian youth possesses in a most pre-eminent degree. He is quick of perception, patient in reflection, adroit and delicate in experimental manipulation, and with these endowments his full success in this study may be confidently foretold.'

While British medical and sanitary officers in India fully realized that the provision of all that is implied in the maintenance of health should be one of the chief concerns of an enlightened government and admitted that a great many positive measures could be adopted in the interest of public health in India, the policy of the Government of India was that of non-interference with habits and customs of the peoples under the plea that an awakening of the public health conscience was a task for Indians themselves. For an alien government the

tors conducive to the incidence of the disease. Megaw's enquiry into the dietaries of the three chief communities of the Punjab, namely the Hindus, the Sikhs, and the Muslims, indicates the possible relationship between diet and stone formation. He found[55] that the incidence of the disease was less among the Sikhs, whose diet was well balanced and more nutritious than that of either of the other two communities. The Sikh diet, which we have described in Chapter Six, is varied and usually includes a liberal supply of milk, fresh vegetables cooked in *ghee* and meat. While the Hindu diet is predominantly vegetarian, the Moslems take a considerable quantity of meat but less milk and vegetables.

These are, then, some of the prevalent diseases in India, which may be ascribed to faulty nutrition. Since the problem is related to public health, it is relevant for our purpose to turn to the State organizations concerned with the health of the people.

Public Health Services and Organizations in India

The British system of public health is unique and provides a pattern to all countries concerned in the formation of their public health policies. Its advancement in England was made possible not merely by progressive stages of legislation which served to spread knowledge of hygienic practices, but by the growth of a wider concept of social service fostered by humanitarian ideals. The spiritual awakening ushered in by the Wesleyan movement, the gradual shifting of philosophical interest from metaphysics to sociology, the comparatively homogeneous character of social organization and the development of the sense of social responsibility—these are some of the potent factors which have helped to extend the benefits of medical science and public health to the majority of the people in Great Britain.

British medical men carried with them the spirit that promoted the growth of their art to distant lands where they went in various capacities and made sustained efforts to put their art into practice. In India they found themselves faced with obstacles arising from poverty in its most acute form. The social habits of heterogeneous races, the ignorance and preju-

coherent policy for public health and sanitation. They introduced a system of giving grants to Provinces for the purpose of initiating sanitary measures both in districts and municipal areas and allowed Provincial Governments to appoint subordinate staffs; but the administration of public health remained highly centralized. Steps were taken towards the provision of facilities for the study of problems of public health and the Indian Research Fund Association was established to widen the scope of investigations. But the question of trained research workers in India became urgent and many expert British hygienists in tropical fields emphasized the need for a proper training of Indian personnel, without whose co-operation and experience practical application of sanitary knowledge to Indian conditions would be extremely difficult. For *subordinate positions, provincial governments offered, through* universities, specific courses but the obvious limitations of the scope and outlook of such a training were largely responsible for the failure to secure Indian personnel of the type necessary to initiate sanitary measures in India; and for the superior staff the Government of India insisted upon a British Diploma of Public Health.

In 1914 a distinguished British medical officer, Sir Leonard Rogers, definitely proposed that a School of Tropical Medicine in Calcutta and an Institute of Hygiene in Bombay should be established for the purposes of both research and training. It was largely through his perseverance and enthusiasm that the School of Tropical Medicine and Hygiene was opened in 1920 in Calcutta. However, for the evolution of an effective public health policy which must provide special facilities for training students to devise and apply measures for improving the health and well-being of the masses, the scope of public health education has to be widened and brought to a higher standard of efficiency.

With the introduction of the constitutional reforms of 1919, certain aspects of public health work were transferred to the Provincial Legislatures; but the control of research was left in the hands of the central Government. On its administrative side the central public health organization of the whole of British India now consists of a bureau with a Public Health Commissioner, a Deputy Health Commissioner, two assistants,

hesitation to interfere with the freedom of social life of diverse communities, even when such freedom is proved to be contrary to the recognized principles of public health, may not be unnatural; but during a long period the responsibility of public health remained entirely under their control, they could have initiated a unified policy in the interest of India; and with their prestige and power they could have influenced public opinion in favour of activities leading to an awakening of the corporate sense in regard to maintaining the health of communities. But their achievement in this matter has been poor. What substantial progress can be made when the annual public health budgets for the whole of British India do not exceed even at their highest a penny or two per head of the population?

A brief reference to the history of the public health organization in India at this stage may be of interest.

Two years after the Indian Mutiny, it became necessary for the Government, then transferred to the Crown, to strengthen the British garrison in India. The high mortality among the troops and the general insanitary environment induced the Government to examine the problem by a Royal Commission which visited India in 1860 and reported in 1863. As a result of their recommendations, three permanent sanitary commissions were established in the three major provinces of Bengal, Bombay, and Madras. The primary concern of these commissions was to reduce the rate of sickness in the army but it involved the proper administration of certain rules and regulations applicable to the sanitary condition of the general population. No attempt was made to introduce a comprehensive sanitary reform 'owing to the financial and administrative difficulties'. A quarter of a century later, with the passing of Local Self-Government Legislation, the Government of India issued a resolution laying down that 'the promotion of sanitation should be regarded as one of the most important duties of all local bodies and of village unions', but when they found that the rate of sanitary progress was exceedingly disappointing, their consolation was that 'in the land of the ox-cart one must not expect the pace of the motor-car'.

The arrival of a great plague epidemic in 1896 and the unrest that followed that disaster stirred informed public opinion but not until 1912 did the Government of India formulate any

which is concerned with the problems of nutrition in India is situated at Coonoor (Madras) where Sir Robert McCarrison initiated his pioneer work. We shall refer to these institutes in the last chapter in connection with an account of nutritional research in India.

To complete our account of the Public Health Service and Organization we give here an outline of the Provincial Administration so far as it touches public health. Each province is divided into divisions which are again sub-divided into districts. Each district has a number of local bodies—a district board for rural areas, and city corporations or town committees for each town. Since the passing of the Government of India Act 1919, the responsibilities of the Provincial Public Health Department have been transferred to a minister in each province, and through a system of grants-in-aid from its meagre budget, supplemented in some cases by local taxes, the local bodies do the best they can to maintain the public health service.

No substantial modification of the Public Health Organization has taken place under the Government of India Act of 1935. In view of the importance of a unified public health policy, the relation of the autonomous provinces with the Federal Government must of necessity be more intimate if public health and sanitary measures for the whole of India are to be made efficient and effective. It is hoped that the Central Advisory Board of Health constituted in 1937 may serve the purpose of co-ordination of public health activities throughout Federal India. In the sphere of administration the process of decentralization should be given further impetus, leading the local bodies to a stage of development when their active co-operation in public health and sanitary measures may be fully assured.

There are, of course, several statutory enactments in India for the purpose of effecting sanitary reforms, and these provide as usual elaborate regulations and precise definitions of administrative duties. They are lacking in only two things: namely (*a*) adequate funds to give effect to the aims of the Acts and (*b*) the firm resolve of the responsible authorities to enforce them. In a country where diverse religious faiths and variegated social customs prevail, where no sustained efforts

and a statistical officer. It is obvious that such a bureau can do nothing more than see through the routine work involved in keeping the Central Government in touch with public health affairs in the provinces.

Owing to the deplorable state of finance, none of the provinces could initiate fresh developments or formulate sanitary schemes; but faced with the primitive state of sanitation throughout the country and with the consequent appalling wastefulness of sickness, the ministers realized the special urgency of training public health workers and urged upon the Government the need of expanding facilities for a thorough education of Indians in all matters concerning public health. For ensuring a degree of success in public health measures, they argued, the responsibility has to be left in the hands of the Indians. At long last the hierarchy of the central Government realized that corporate action necessary for ameliorating the deplorable environment in which the masses of the people live cannot be taken by them and, to quote the words of the Public Health Commissioner with the Government of India, 'to be effective it must carry conviction and establish its position against immemorial conservatism and tradition, it must therefore be done by Indians'. While the Government were in 'full sympathy' with proposals for establishing institutes or schools devoted to specialized training in public health, they could not offer the requisite financial support for their fruition.

The opportunity came when the Rockefeller Foundation offered to provide the entire cost of building and equipping an All-India Institute of Hygiene and Public Health on the condition that the Government of India would meet the recurring cost of staff and maintenance of the Institute. The Rockefeller Foundation stipulated that the Institute should conduct its work in such a manner as to serve the whole of India. The Government of India accepted the offer and the building was completed in 1932 on a site adjoining the Calcutta School of Tropical Medicine. One section of the Institute, opened in 1933, is devoted to research and training in biochemistry and nutrition. Two main lines of investigation are being followed at present, namely, determination of nutrient values of the common Indian foodstuffs, and surveys of dietary habits of the various races and communities in India. The other institute

consumer. Besides, one must take into consideration the alarming fact that India is becoming a dumping ground for every variety of manufactured infant food and adulterated drug.

But, of the many sanitary sins, the least excusable is the one which allows some of the principal foods of the people to be exposed to contamination and does not exercise adequate control of their purity. The conditions of milk supply in the Indian cities and towns are still in a primitive state and there is no end to the fraudulent practices. Milk is usually adulterated with water, flour, rice-gruel, and in certain seasons with milk expressed from shredded coconut. The chemical composition of milk is not constant as it depends upon such factors as the breed, the kind of fodder, and the facilities for grazing, and it is held that owing to wide variations in the quality of milk in different parts of India, it is not possible to formulate a statutory standard of its purity for the country as a whole. But it is certainly not impossible to introduce uniformity in the milk regulations within each province. Milk is an ideal medium for the growth of pathogenic and other forms of micro-organisms and therefore its bacterial purity is of much greater hygienic importance than its chemical composition. The health authorities in India cannot overlook the fact that owing to the practice of adulterating milk with water, its bacterial content may have all the characters of a sewage effluent. It is, moreover, no consolation to a nutritionist to be told that the universal practice of boiling the milk twice serves to assure the bacterial purity of milk. For this indispensable article of food, India must organize dairying upon a hygienic basis and adopt the method of pasteurization by which the physical properties of milk as well as its nutrient constituents remain unaffected.

We need not pause to consider the extent of the adulteration of other common articles of food which, in a pure form, have almost disappeared from the Indian market. The classes of the population engaged as middlemen and vendors of foodstuffs are usually poor and devoid of the sense of responsibility, but they are shrewd enough to recognize that constancy in price has a special appeal to the Indian consumer. Consequently the practice of adulteration follows for the most part the trend of the prices of foodstuffs, and with its upward tendency, various methods of adulteration are adopted to keep prices as near as

have been made for the education of the people, and where the struggle for a bare existence usurps all strength, the problem is not easy; but the history of public health abundantly corroborates the fact that the opposition from conservative elements of society can be overcome by the pursuit of a deliberate policy. When, for example, Sir James Simpson advocated the use of chloroform in labour, the clergy of England were loud in denunciation of the practice as being an 'unmitigated piece of iniquity'. But this opposition has been overcome. Recently the popular British Press chuckled when the Ministry of Health appointed an Advisory Committee on Nutrition. To the bulk of the people even in advanced Western countries, nutritional problems do not exist; but their conservative attitude is not offered as a plea for inaction in matters of health, physique, and nutrition of the nation.

Pure Food Acts

Foodstuffs, though originating from healthy sources, may become contaminated subsequently with pathogenic micro-organisms; or they may be deliberately adulterated with substances prejudicial to health. The enforcement of pure food regulations should, therefore, fall within the scope of Public Health Administration. In a country like Great Britain where supplies of food are drawn from many different sources, administrative control of the purity of food must of necessity become an integral part of Public Health Policy, but its need in the circumstances of Indian conditions is equally urgent. Lack of state surveillance, apathy of the informed public, ignorance and poverty of the masses are the circumstances under which unadulterated food has become almost a rare commodity in the Indian market. Public Health Administration in India can no longer overlook the importance of measures for the purpose of evolving suitable systems of food control.

Although at present supplies of food available to us are mostly home-grown and Indian dietaries do not usually include articles of preserved food, there is every indication of a growing demand for products of the food-preserving industry. With the development of that industry, laws dealing with food hygiene have to be enacted in order to safeguard the interests of the

no adequate co-ordination between Provincial Governments and local government bodies, without whose concerted efforts the whole system of inspection and supervision breaks down. Of course, legislative measures by themselves cannot achieve the object unless they are adequately supported by sustained methods of educating the public. In the interest of the health and welfare of communities, Provincial Ministries of Health should now amend the existing Acts and explore all avenues of approach for concerted action both in regard to the administration of Pure Food Acts and to the spread of knowledge of food hygiene.

Maternity and Child Welfare

The maternity and child-welfare movement is comparatively new even in the advanced countries of the West. In England the first Infant Welfare Centre was opened through a voluntary agency in 1904 but since then the growth of the movement has proceeded apace. There are at present over three thousand maternity and child-welfare centres in England and Wales of which nearly one thousand organizations are run by voluntary agencies. Their programme of activities includes, in addition to measures for temporary relief, an intensive educational campaign and practical demonstrations of what can be achieved by personal hygiene, and persistent efforts towards the improvement of environment. The movement has to some extent contributed to the decline in the infantile death-rate in England and Wales. From 154 deaths per 1,000 children born in 1900, the figure is brought down to 64 in 1933.

The maternity and child-welfare work in India is in its initial stage and is chiefly confined to a few of the larger towns. There are not more than 600 such organizations throughout India and even these are irregularly distributed. For example, the United Provinces with an area of 106,295 square miles have over 166 centres and the State of Hyderabad (Deccan), with an area of 82,698 square miles, has none. Except in certain model village settlements it has not touched the rural areas although the need for its expansion is frequently urged by those who are able to discern in the movement one of the effective means of contact with the neglected masses. The

possible to a normal level. One possible measure for reconciling the conflict of the various interests would be to organize regulated markets throughout the country on a proper basis.

It is here, we believe, that there is room for *real* social service activities through voluntary associations. The gross forms of adulteration usually practised by oil-mill owners, dairymen, and grain dealers and the consequences of using adulterated foodstuffs upon health should be made known to the consumer by every available means of propaganda. Once the consumer is fully aware of the precise nature of adulteration and insanitary practices to which the foodstuffs are liable, he will make a contribution towards the control of their purity by restricting his consumption or by putting the pressure of collective opinion upon the dealers.

But the State cannot remain indifferent to a matter of food adulteration which has an important bearing on public health. Where public opinion is not sufficiently alert, its duty is to take the initiative by enforcing legislative enactments.

There is no Public Health Act for British India but in some of the provinces some sort of legislation exists for dealing with foods and drugs. Most of these Acts are not sufficiently comprehensive to prevent the sale of adulterated foodstuffs; nor have they put a substantial check on those abuses which so often affect the health of the community. Local authorities which are concerned with the administration of these Acts have not even succeeded in enforcing them within the limits of their restricted scope.

'In towns of Bengal,' writes the Government of Bengal in their review of the working of municipalities, 'where retail trade is extensive, municipal executives are often reluctant to antagonize influential tradesmen by insisting on a high standard of purity of foodstuffs'! Fines imposed on those prosecuted for food adulteration are usually inadequate and regulations laid down by the Acts are not given reasonable publicity. The difficulty of setting up a standard of purity and also of administering such a standard where it is formulated is offered as an excuse for the failure of legislation in exercising an effective control over the purveyors of both fresh and manufactured articles of food; but the truth is, even the best regulations become ineffective unless they are properly enforced. There is

nutrition; and therefore, to quote McCarrison, they 'are condemned from their mother's wombs to a subnormal or diseased existence as certainly as is the engine of the best motor-car when not provided with efficient lubrication or when supplied with an improper fuel'.

The maternity and child-welfare organizations should therefore concentrate their efforts more upon the problem of nutrition than on the treatment of the symptoms arising from malnutrition and undernourishment. The problem of paramount importance is, of course, to ensure an adequate and *safe* milk supply. What measures have been adopted in other countries and how we in India should face the problem, will be discussed in subsequent chapters. Here we would raise a note of warning, that the growth of our import trade in 'infant foods' of all sorts and descriptions can no longer be viewed with complacency. Grave nutritional disturbances in the new-born child are due to the injudicious use of these foods which are finding their way to Indian homes. Most of these contain an excess of carbohydrates and are deficient in proteins and vitamins. Even when babies grow temporarily fat on them and look healthy they do not possess the stamina of an infant fed with natural milk. The incidence of infantile liver complaints and even rickets may often be traced to the use of certain brands of these preparations containing an excess of fat.

The Provincial Health Services should therefore examine the various claims of these infant foods and issue an authoritative account for the guidance of the public. We would especially appeal to the Indian Vernacular Press to take great care in the matter of advertising these commodities. Through the channels of the maternity and child-welfare organization and other institutions, knowledge about the basis of infant feeding under the specific conditions obtaining in India should be widely disseminated, and in order to give some practical exactitude to these considerations, our medical authorities in co-operation with nutritional experts should be able to indicate how best the nutrition of the new-born and the child can be made effective without the risks inherent in the use of the glorified infant foods.*

* For the import of milk foods for infants and invalids, see Table VIII, p. 167

trouble is that this form of social service has not as yet assumed the character of a serious national concern. Its outlook is narrow and activities restricted; its ideology springs from a kind of pseudo-religious philanthropy; its organizations are chiefly directed by untrained personnel and depend on patronage; and its funds are meagre. It has to be admitted that so far the movement has not made any difference in the rate of infant mortality or in the direction of health education.

Nevertheless, the movement does signify the awakening of the social conscience in India, and we believe that if the organizers of maternity and child-welfare work obtain accurate figures of preventable deaths, both of mother and infant, and initiate an educational campaign based not so much upon temporary relief of the distressed as upon the urgent need of attacking the problem at its roots; if their efforts are now directed towards the training of personnel on whose efficiency and foresight the future of the movement will depend; and if the local self-governing bodies realize that an increased expenditure to foster the movement would ultimately lead to economy, we will then succeed in laying its foundation upon a more secure basis. The first and foremost step towards better organization of maternity and child-welfare work is to make proper provision for the training of personnel. It is only through trained personnel that the results of medical research can be applied to this work. We have now an All-India Institute of Hygiene and Public Health in Calcutta where a section devoted to this purpose has actually been operating for the past three or four years and is likely to become permanent; but owing to the financial circumstances of the Government of India, its activities have been restricted to a narrow scope. It now rests with the various Provincial Governments to take the initiative in providing a thorough course of training for a body of officers to carry out the maternity and child-welfare work in a manner warranted by the special circumstances of India.

Our legislators, publicists, social workers, and medical authorities should realize that the problem of nutrition has a very close connection with that of raising the standard of health of the mother and the infant. There are over eight and a half million annual childbirths in India and the diet of many millions of those born is below even a minimum standard of

voluntary agencies, are largely responsible for inadequate results. An occasional visit of a health inspector or a propagandist, followed by a discourse on the principles of health and hygiene, will not modify people's mode of living. And yet, through judicious adaptations of some of the modern technique of propaganda, health instruction can be made really stimulating and educative. The personnel entrusted with the task should not merely recite formulae of health directions or perform routine work during their visits in rural areas. It is necessary to explain in the simplest terms possible the underlying causes of persistent ill-health and incapacity which breed misery and reduce human efficiency. If traditions are to be replaced by a rational basis of knowledge, if inertia is to be overcome by awakening of 'health consciousness', the task cannot be relegated to untrained propagandists or to sentimentalists. An effective propaganda would require training, tact, local knowledge, and inspiration for genuine social service on the part of those who undertake the task. Only through sustained and co-ordinated efforts can we succeed in enlisting the co-operation of our rural leaders in arresting the dysgenic forces which are undermining the health of all races and communities in India.

It is held that classroom instruction with the help of a mere health primer would be useful. But any one familiar with the staff, equipment, and environment of a village primary school in India will agree that the conditions there are utterly unfavourable for imparting any effective teaching of health and hygiene. The school is usually just an ill-constructed mud hut with no sanitary arrangements; the water supply is often bad. The entire staff consists of one ill-paid teacher whose habits in many instances are not illustrative of what personal hygiene should be. It is no wonder that health propaganda has made so little impression upon our conservative rural communities.

We are here concerned with one aspect of the health movement—the food habits of people. In our opinion the first step should be directed to arousing the interest of the villagers in a campaign for the improvement of nutrition of their children, not by mere propaganda but by instituting physical examinations of the pupils. This should be done by a competent medical man in the presence of the villagers, and each parent should be

Health Education and Propaganda

It is obvious that an organized health service should include effective propaganda in regard to the relation of dietary habits and health. In some of the Western countries, as we shall see in a subsequent chapter, popular education concerning nutrition has to a considerable extent been successful. Specific instructions as to the ways and means of correcting the deficiencies in diets form a part of the general education, and its inclusion in the school health programme has perceptibly increased the *children's knowledge of the principles of dietetics. Simultaneously* with teaching, the organizations for school feeding offered a practical demonstration of the value of balanced diet.

In India matters relating to 'health education' are treated with indifference or in an academic fashion. Propaganda organized either by the Government or non-official bodies is devoid of coherent plan and lacks vigour. Health lectures are often delivered in terms wholly unsuitable for the comprehension of the audience; posters, diagrams, charts, and other familiar accessories are assembled and exhibited in such a manner that they give the impression to the masses that they are being entertained with a 'tamasha' (amusement). And such 'tamashas' springing as they often do from sporadic organizations cannot be fruitful of any positive results. The propaganda carried out by official agencies is equally uninspiring, for their health inspectors have no special training either in rural problems, in relation to the subject of their propaganda or in the technique of addressing an illiterate but shrewd audience. It is not realized that health education is 'the sum of all efforts to modify human conduct and attitudes so as to raise the health levels of individuals and of the community'. It must embrace the co-ordinated activities of all those concerned in education, public health, and agriculture.

The task is not easy, especially in a country where the bulk of the population is illiterate. Poverty, illiteracy, rigidity of social customs, superstitions, prejudices, all combine to present formidable obstacles to the development of what is known as 'health consciousness'. But it must also be admitted that the measures so far adopted either by the Public Health Service or

the villagers themselves. What is important is that our public bodies should realize that the improvement effected by such measures is a matter of economy to the state and the society.

Thirdly, it should not be beyond the bounds of practical politics to induce certain groups within the rural community having special prestige to take a lead in this matter of adjusting food habits to correct dietary deficiencies. The central question here is the method of approach. We believe it should not be difficult, to cite an example, to secure the active co-operation of the authorities of our temples and mosques where during festivities they organize mass-feeding. On such occasions a temple priest or a moulovi may be trained to address the guests. Suggestions in regard to proper diets based on foodstuffs easily available should be followed by simple statements showing the relation between health and nutrition. Here the importance of using germinated cereals and legumes, leafy vegetables, unpolished rice, and *gur* instead of refined sugar, may be stressed; here they may be told that an excess of sugar in their dietaries is injurious and may even predispose to disease; and here it may be explained that the outbreak of epidemic diseases is not *Kismet* (Fate) or an inevitable curse of God and that we fall an easy victim to them because of our low power of resistance, the result of inadequate and improper dietaries.

Fourthly, in matters of elementary sanitation, dietary reforms, and education for positive health in a community, organized propaganda through women may be of immense service. Appeal for the infants and children of the next generation, coming from members of their own sex, would have a special significance for the majority of our women. Within the area of each Local Board it should therefore be made possible to place a trained woman *resident* so that she may be in constant touch with homes in a surrounding group of villages. After all, the problem of malnutrition has to be tackled in the home, and once we succeed in showing the village mother how best she can improve the diet of her family within the restricted means at her disposal, the way to a great advance will undoubtedly be made. The woman resident in co-operation with district health officers will examine the undernourished within her jurisdiction and will keep a register of each case. We believe that if she gains the confidence of the villagers and once they

provided with the result of the diagnosis. It will be explained to them that there are certain indications of ill-health not discernible without the aid of a medical examination which are due to nutritional defects and that they can be remedied by a proper understanding of food values and by adjusting the child's diet according to his needs. The cost of the medical examination, which should be repeated at intervals of every three months, must be borne by the District Boards, where a complete record of diagnosis of the cases should be preserved. An abstract report of medical examinations and periodic progress made in removing some of the causes of defective nutrition will be made available to the Press and to the Ministry of Education and also of Public Health. The medical men holding these examinations must have adequate knowledge of nutrition and should be able to suggest dietary changes advantageous from a physiological point of view as well as from the consideration of availability and economy. Their aim must be to create an atmosphere of confidence so that a sympathetic response on the part of the rural community may be evoked in starting a campaign for better nutrition and better health. Such a step we believe would introduce a new element in the conception of education generally held by the villager. That the care of the body is also the concern of the school will impress our illiterate but unsophisticatedly intelligent rural folk, and once their confidence is gained they will do their utmost to follow the guidance of expert advice in regard to the much-needed adjustment in their children's dietary. We must bear in mind that our rural folk are peculiarly susceptible to the human touch. Without it, no propaganda will ever succeed in India.

Secondly, the children whose growth is found to have been seriously impaired by nutritional defects will need special consideration. Village elders may be persuaded to raise a fund for the purpose of providing adequate nutrition to this group. Small contributions on ceremonial occasions would provide a nucleus of such a fund whose management should be entrusted to the school committee. Arrangements for feeding the group of ill-nourished children should be made in school. The expense of a school kitchen and a few cooking utensils is very slight, and I believe it should not be difficult to obtain it from

China, a centre of social life. If they become living institutions, we shall then find appropriate and effective channels through which the people can be easily reached. Most of the temples are richly endowed and ceremonies are performed there with considerable splendour in the presence of an audience consisting largely of the shrivelled bodies and protruding ribs of the half-naked men, women, and children. Such a spectacle of humanity cannot be pleasing to God; nor can it represent our attitude of true worship of Him who is conceived as the indwelling Spirit of man.

Conclusion

We have attempted in this chapter to describe the general state of public health in India and the organizations that are concerned with the problem. The state of public health and of the environmental conditions which concern the lives of the Indian masses are decidedly depressing. That it is an enormous liability and involves India in a vicious circle has become an indisputable fact. Her leaders must now realize that the longer they take to liquidate this crushing liability of ill-health and undernourishment, the worse the situation will become.

Diet is a vital factor both in attaining and maintaining health. Investigations show that the conditions of people subsisting on an insufficient diet affect in subtle ways the standard of public health. For this reason the provision of adequate and proper nutrition is recognized in every civilized State as an integral part of its public health policy, and the responsibility of the autonomous Indian provinces in this respect is of a most serious character; for, if the physical deterioration of the wealth-producing classes is not arrested, India's economic life will ever remain depressing and political bondage perpetual.

are made to understand that it is diet not medicine which ensures health, it may not be difficult to organize kitchen gardens on a co-operative basis. In initiating the kitchen garden movement, landlords should offer all facilities for evolving a system of production and village elders for marketing the produce *within* the community.

Lastly, one main cause of the failure of propaganda activities in rural and semi-urban areas is the absence of any local or regional organization through which the work may be followed up. Most of our social service or welfare institutions favour a city environment with occasional excursions into rural areas; and they do not represent a corporate sense of the community which they propose to serve. The true function of a 'welfare movement' is to revive the *esprit de corps* of the rural communities. Therefore if a beginning of an intensive health propaganda is to be made, the task must lie with the local self-governing bodies. Instances of neglect by these bodies in matters of sanitation are unworthy of the responsibilities entrusted to them. It is the growth of municipal governance and local self-government in England that has paved the way for deriving benefits from what the science of medicine and hygiene can offer. It is through local organizations alone, whether voluntary or official, that the people and the state can co-operate for the maintenance and improvement of public health. We in India have overlooked the entire field of rural health and have left our rural areas without any corporate institutions which should have concerned themselves with the welfare of all sections and classes of the community.

A beginning might be made by the establishment of small bodies in a number of typical areas, whose functions would comprise survey, propaganda, assistance in enforcing public health regulations and other activities related to the improvement of nutrition and physique. Through such units of organization the task of public health authorities may be adjusted to local needs; on the other hand, they may develop into effective agencies for co-ordination of services that concern the welfare of the people.

We venture to offer a suggestion which may well provide a starting-point in the movement towards better health and nutrition in India. Our temples should be, as they are in

China, a centre of social life. If they become living institutions, we shall then find appropriate and effective channels through which the people can be easily reached. Most of the temples are richly endowed and ceremonies are performed there with considerable splendour in the presence of an audience consisting largely of the shrivelled bodies and protruding ribs of the half-naked men, women, and children. Such a spectacle of humanity cannot be pleasing to God; nor can it represent our attitude of true worship of Him who is conceived as the indwelling Spirit of man.

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[illegible] producing classes is not arrested, India's economic life will ever remain depressing and political bondage perpetual.

CHAPTER FIVE

A Brief Account of Indian Foodstuffs

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Since our immediate task is to make use of the available food resources to the best advantage, it may be useful to give here an outline of the common foodstuffs which enter into the Indian dietaries. It is not within our province to go into details of food production in India; our purpose will be served if we indicate the sources upon which Indian communities depend for the supply of their nutritional requirements.

Foods fall into two main divisions: those of animal origin and those derived from the vegetable kingdom. As a source of nutrients, the fundamental difference between these two classes lies in the provision of carbohydrates (that is, starch and sugars) which are obtainable chiefly from vegetable foods.

Food of Animal Origin

Food of animal origin may be classified into four groups: (*a*) Milk and Milk Products; (*b*) Eggs; (*c*) Fish; and (*d*) Meat.

(*a*) *Milk and Milk Products*

Milk is regarded as nature's complete food, and owing to its richness in most of the essential food constituents it should be accorded a foremost place in human dietary. To the infant, it *is indispensable; to the young child it should invariably* form the essential protective food during the growth period, and for the adult it is a most valuable adjunct to the normal diet.

It is composed of proteins, fats, carbohydrates, inorganic salts, and vitamins, and all these five nutritive ingredients are so harmoniously blended that it supplies all essential factors necessary for the growth of the young animal.

We are concerned here with cow's milk. The wide variations in its composition are largely due to the breed, age, course of lactation of the cow, and to the amount and character of her ration. It is well known that the difference between the milk of the indigenous Indian breeds and imported cattle is very striking.

The following table composed from various sources gives an average composition of cow's milk together with the limits of variation.

TABLE VII*

Average Composition of Cow's Milk

Ingredients	*Percentage*	*Limits of Variation Percentage*
Water	87·7	83–91
Solids	12·2	9–17
Fat	3·4	2–8
Casein	2·7	2–4·5
Lactalbunin / Lactglobin	0·5	0.2–1·3
Lactose (milk-sugar)	4·7	3–6·6
Ash (inorganic substances)	0·7	0·6–1

Wherein lies, we may ask, the superiority of milk over other foods? In the first place the proteins of milk are of high biological value and supply nearly all the amino-acids which are needed for 'protective' nutrition. The carbohydrate of milk is present in the form of lactose or milk-sugar. It is not as sweet as cane sugar; nor is it readily fermented; and because it is so easily digested, its use is recommended when a high calorie carbohydrate diet is wanted. It is lactose which, under the influence of certain micro-organisms, produces lactic acid, causing milk to sour. The fat of milk floats in the liquid in extremely fine globules. This highly emulsified fat is very easily digested and is associated with the fat-soluble vitamin A. The inorganic substances in milk add much to its unique value as a protective food. No other food compares with it as a source of calcium and where milk consumption is high there is no risk of a calcium-phosphorus deficiency in the diet. Milk is poor in iron although the small amount present is of great value in the maintenance of a nutrient balance.

* Calculated from various sources.

As milk is a rich source of vitamins A and D, one of the subjects of absorbing interest in dairy research is to ascertain the conditions under which these food accessories vary. It is found that the vitamin content of milk is particularly dependent upon the feeding of the cow; it is higher, for example, in the milk obtained from stall-fed Scindi breed than in that of a pasture cow of indifferent stock. A recent investigation in Bengal, has shown[56] that an average sample of cow's milk is about 60 to 70 per cent poorer in ascorbic acid content than the milk obtained in England. Obviously the low vitamin content in the milk studied in Bengal is due to the poor nutrition of the cattle and to the inefficiency of its breed. But the average milk yield of indigenous cows throughout India is exceptionally low.* Even our selected breeds (e.g. Tharparkar, Hariana) do not give more than 3,000 pounds of milk in a lactation. The herbage of natural grasses is totally inadequate for our milch cattle, the available fodders are generally deficient in minerals and ordinary pastures are almost barren.

Milk is a perishable article as well as an ideal medium for the growth of micro-organisms. Consequently in dealing with this valuable human food, various methods have to be adopted in order to ensure both its keeping properties and bacterial purity. One of the methods is known as pasteurization. Milk either in bulk or in the bottle is exposed to a temperature between 145 degrees F. and 150 degrees F. for about 30 minutes, after which it is cooled. While the physical properties remain unaffected, the temperature employed in pasteurization kills all non-spore bearing organisms. The process does not, however, sterilize the milk because a certain number of organisms escape destruction. Nevertheless, pasteurization does minimize the risk of milk-borne diseases and preserve the keeping quality of the milk.

We need not pause here to dwell upon the nature of the controversy, rife in the West, as to the advisability of pasteurization because of its adverse effects upon the nutritive properties of milk. The concensus of opinion is in favour of the process and it is widely adopted in all countries where the problem of milk supply has been taken in earnest; in circum-

* The average is only a little over 600 lb. per year, which would represent an average daily yield varying from 4 to 6 lb.

stances where the principles of hygienic milk production are not likely to be observed compulsory pasteurization is recommended.

In India at every step from the milking process down to the vessel from which milk is sold, it is open to serious contamination. Here, in a warm climate, micro-organisms of different kinds find in milk a favourable medium for growth; therefore the only way of keeping the milk sweet or rendering it safe for human consumption is to boil it as soon as possible. The practice does of course affect the nutritive value of milk but serves to assure, to a great extent, freedom from pathogenic bacteria. The heat treatment reduces the calcium content by about 50 per cent and affects vitamin C; Schwartze and his fellow-workers found[57] that about 20 per cent of vitamin C is lost when milk is boiled five minutes. It is, however, claimed that the protein in boiled milk is more digestible than that of raw milk. Milk should be heated slowly, and it is a rational practice to submit boiled milk to aeration.

To Indians of every class, it is unnecessary to stress the value of milk as food; they know it and are fond of milk and milk-products; owing to its adaptability for combination with various articles of diet, milk has a place of honour in Indian dietaries. Intensive propaganda such as is carried on in the West for increasing milk-consumption is therefore unnecessary in India. The most essential step towards the improvement of the nutrition of our people is to facilitate the production and distribution of milk; but the perfunctory nature of efforts so far directed by the Government to assist the dairy industry is yet another example of their failure to apprehend the realities of the day-to-day life of the peoples. A considerable proportion of the Indian people dislike meat, partly from natural inclination and partly from religious scruples, and consequently the supply of animal protein and fat has to be met through milk alone. And yet the consumption of milk in India* is so incredibly low that its liberal use even for infants and mothers is unknown.

Milk of buffalo and goat is also used in India. *Buffalo milk* is richer in fat and proteins, but it is not relished as a pleasant drink although it is consumed in most parts of India. A great

* See Appendix III.

As milk is a rich source of vitamins A and D, one of the subjects of absorbing interest in dairy research is to ascertain the conditions under which these food accessories vary. It is found that the vitamin content of milk is particularly dependent upon the feeding of the cow; it is higher, for example, in the milk obtained from stall-fed Scindi breed than in that of a pasture cow of indifferent stock. A recent investigation in Bengal, has shown[56] that an average sample of cow's milk is about 60 to 70 per cent poorer in ascorbic acid content than the milk obtained in England. Obviously the low vitamin content in the milk studied in Bengal is due to the poor nutrition of the cattle and to the inefficiency of its breed. But the average milk yield of indigenous cows throughout India is exceptionally low.* Even our selected breeds (e.g. Tharparkar, Hariana) do not give more than 3,000 pounds of milk in a lactation. The herbage of natural grasses is totally inadequate for our milch cattle, the available fodders are generally deficient in minerals and ordinary pastures are almost barren.

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* The average is only a little over 600 lb. per year, which would represent an average daily yield varying from 4 to 6 lb.

TABLE VIII

Imports and Exports of Dairy Products in India

Imports

Year	*Butter*	*Cheese*	*Ghee*	*Milk Condensed and Preserved*	*Milk Foods for Infants and Invalids*
	Cwts.	Cwts.	Cwts.	Cwts.	Cwts.
1930–1	2,625	10,433	864	226,853	13,378
1931–2	3,570	7,349	2,415	185,925	11,844
1932–3	3,772	8,858	90	172,332	10,317
1933–4	5,106	9,871	112	171,870	12,027
1934–5	6,265	10,924	132	180,942	9,174
1935–6	7,708	10,546	371	209,214	10,395

Exports

Year	*Butter*	*Cheese*	*Ghee*	*Milk Condensed and Preserved*	*Milk Foods for Infants and Invalids*
	Cwts.	Cwts.	Cwts.		
1930–1	4,337	52	31,123	—	—
1931–2	2,879	54	27,294	—	—
1932–3	2,241	34	21,837	—	—
1933–4	1,911	29	24,418	—	—
1934–5	1,898	29	25,526	—	—
1935–6	2,289	31	24,030	—	—

Over 65 per cent of the total output of milk is used for the manufacture of various indigenous dairy products. Of the important milk products, *butter* is universally favoured in the Western countries for its high fuel value, taste, and flavour. It contains the fat of the milk, worked into a homogeneous mass in the process of churning and is perhaps the most easily digested form of fat available to us. It is one of the most concentrated of all dairy foods. Well-prepared butter should contain as much as 90 per cent of fat, 8 per cent of water, and 2 per cent of salt and other milk components. Most of the organized dairies manufacture butter from pasteurized cream which has been 'ripened' by the addition of lactic acid bacteria. The total output of creamery butter in India is, however, small, although demand for it in recent years has increased. *Ghee* is clarified butter and constitutes an important item in

bulk of this milk, however, is utilized for the manufacture of *ghee*, a kind of soft cheese, curd, and other milk-products. Both for dairying and draft purposes, buffalo has come to stay as an important factor in Indian agricultural economy and sustained efforts should be made for the improvement of its breeds. *Goat's milk* is richer in inorganic constituents but is not suitable for infant feeding because of the presence of certain insoluble acids. It is, however, used by the poorer classes for this purpose when the period of maternal nursing cannot be extended. Analysis shows that its phosphatic content differs from that of cow's milk and it is rich in iodine. Those who advocate the use of goat's milk recommend that it should be taken raw because of its superiority in vitamin B complex. Its food value depends, of course, on the quality of grass, but this neglected animal has also to subsist in India usually on scanty and poor pasture.

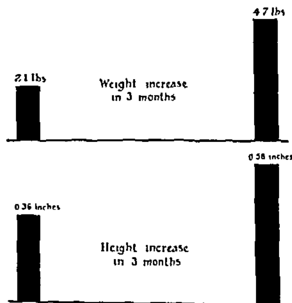
That the dairy industry in India—a country where various forms of milk products are so favoured by the people whose dietary is largely vegetarian—should be in such a state as it is to-day is ample evidence of the lack of any relation between the agricultural policies of the State and the dietary needs of the people. Try as you will, it will not be found feasible to plan proper dietaries for Indian communities without an adequate provision of milk and milk products. There is indeed no other means by which the nutrition of our people can be safeguarded. The problem of developing the dairy industry in India is therefore closely related to that of human nutrition, and no time should be lost in organizing that industry on a national scale. It is, we venture to think, more vital than the *Khaddar* and in a more desperate state.

Meanwhile, imported milk products supply a small portion of our requirements. Once we sufficiently realize the importance of dairying, the supply of butter, cheese, condensed milk, and infant foods from foreign countries would be unnecessary. Happily in recent years there has grown up a considerable internal trade in certain classes of dairy products, but the forces that should be mobilized for the dairy industry in India are still scattered.

In the following table, we give the figures for imports and exports of dairy products in India during the last six years.

THE IMPROVEMENT OF SOUTH INDIAN DIETS BY SKIMMED MILK.

(Growth of Children).



Eight ounces of liquid skimmed milk were given daily.

Indian dietaries. The deficiencies of a high cereal diet are largely corrected by its use. The best quality of ghee is obtained from the milk of cows, but owing to its scarcity the milk of the buffalo is largely used for its preparation. Since the demand for ghee, a good source of animal fat available to the vegetarian Indian, is greater than the supply, the practice of adulterating it with vegetable fats derived from cottonseed, poppyseed, groundnut, mahua, and other similar inexpensive oils is extremely common. It is interesting to note here that adulteration is usually effected, not by the dairymen, but by the traders. Some of them do not even hesitate to use fats obtained from the carcases of diseased and dead animals! The vast majority of the people, however, cannot afford ghee of any kind and its place is taken by various kinds of vegetable oils.

Of the milk products, *curd* is extensively used throughout India by all classes of people. It is a nourishing and refreshing food, easily digested. *Dahi*, as it is called in Indian languages, is a form of fermented milk something like the Yoghourt prepared in Europe and in America. Milk is boiled and a ferment such as a little stale dahi or tamarind or lime juice is added when it is nearly cold. While plain sour milk is drunk as a common beverage, curd is used in various preparations. Rice, curd, and salt constitute a meal of the poor classes and it is especially favoured by those who do not eat meat or fish. For a diet predominantly consisting of carbohydrates, curd is helpful in neutralizing the effects of intestinal fermentation. Curd contains about 4·8 per cent protein, 3·5 per cent fat, and the milk-sugar is transformed into lactic acid. Investigations show that during the curdling process the vitamin in milk is somehow stabilized. The food value of curd is now widely recognized but it also should be carefully prepared under hygienic conditions.

Casein is prepared by curdling milk with some acid substance such as citric acid or alum. Acid acts upon the casein and soluble calcium remains in the whey. The nutritive value of casein depends of course on the quality of milk. When prepared from whole milk, it contains about 22·6 per cent protein, 18·6 per cent fat, 1·75 per cent inorganic constituents, and less than 1 per cent carbohydrate. A great variety of Indian sweets are prepared with a combination of casein and sugar.

There are various processes adopted in the West for manufacturing and curing different qualities of cheese but in India only cream cheese, freshly made, is favoured. Certain tribes in northern India make a kind of cheese known as milk-bread, which is somewhat like a crude form of cheddar.

Buttermilk is the residual product that remains when fat is removed from milk or cream, either sweet or sour, in the process of churning. If not excessively diluted the nutritive value remains sufficiently high to be of use in dietaries which do not include milk at all. It is generally obtained as a by-product of buttermaking, and if dairying in India were practised under modern hygienic conditions, buttermilk would not be regarded as 'a drag' on the industry. Various forms of beverage (sherbet) prepared from curd are also known as buttermilk in India. If the fat is removed from curd, the nutritive value of the residue is not diminished to any great extent except in regard to fat and fat-soluble vitamin A; but if buttermilk is derived from the process of churning cream, its nutritive value is relatively low, since most of the nutrients other than fat are left in the original milk from which the cream was separated. Buttermilk may also be prepared from either whole or skimmed milk by using certain forms of fermenting bacilli. All forms of buttermilk are welcome as refreshing drinks and they have also therapeutic value. Abt and Feingold[58] advocate the use of carefully prepared buttermilk in infant feeding, especially if infants show a tendency to digestive troubles.

Skimmed milk is milk from which the greater part of the milk fat has been removed. Its nutritive value is much the same as whole milk except in fat and vitamin A. The high calcium content of milk is retained, but the percentage of fat depends of course on the methods employed in skimming. The milk skimmed by a properly run separator does not contain over 0·1 per cent fat. Since the proteins, carbohydrates, and inorganic constituents of milk are retained in skimmed milk it may well be an important item in dietaries which are deficient in animal protein and contain little fresh vegetables. Produced under hygienic conditions, skimmed milk can somewhat mitigate the shortage of milk supply at least for children and mothers; but the problem of its distribution under Indian

fairly free from contamination and may therefore be used for infant feeding; it keeps well and is convenient for ready use; and owing to its small bulk, transportation is easy. Carefully prepared milk powder is not difficult to reconstitute in cold water. It should, however, be remembered that it can never replace the whole milk and that it is rather poor in anti-scorbutic properties and in fat. In recent years, milk powder has been used as food for infants in urban areas in India, but it should be supplemented by the addition of orange, lemon, or tomato juices and some form of liver oil.*

(*b*) *Eggs*

The egg contains a wide range of nutritive substances. It is moderately rich in proteins of high biological value, easily assimilated fats, and vitamins A and D. The digestibility of egg protein is practically as good as milk or meat protein and it is therefore a valuable supplementary food particularly in a dietary rich in carbohydrate. As a suitable food for the young, the egg ranks next to milk and it is a most desirable adjunct to the diet of the expectant mother and of those suffering from anaemia. The proteins of the egg may be classified in two main groups: ovalbumen present in the white, and ovavitellin in the yolk. These differ in amino-acid content but both supply proteins of the best quality. A comparison of the white and the yolk in regard to their nutritive values shows the superiority of the latter, in essential protective food-constituents. Egg yolk contains practically all the fats which exist in a form of fine emulsions and a liberal amount of vitamins A and D. It also contains a large part of the inorganic elements such as calcium, phosphorus, and iron, all in forms readily absorbable into body

* We reproduce here a table of milk equivalents taken from one compiled by Seymour-Jones[59] which may be helpful in reconstructing liquid milk from various forms of preserved milk.

TABLE: MILK EQUIVALENTS

[illegible]	2 to 3 lb. fluid milk
[illegible]	3 to 4 lb. fluid skim milk
[illegible]	2·33 lb. fluid milk
[illegible]	2·75 to 3·25 lb. fluid skim milk
[illegible]	2·25 lb. fluid milk
1 lb. dry milk	8 lb. fluid milk
1 lb. dry skim milk	10 lb. fluid skim milk

conditions bristles with the same difficulties as the transport of whole milk.

Whey is another refreshing drink obtained in the process of making casein. It contains all the milk-sugar, albumin, and a small amount of fat and is fairly rich in inorganic constituents, especially calcium; if prepared with lemon juice, vitamin C is added to whey.

The nearest approach to *condensed milk* is the indigenous preparation known as *khir*, which is taken fresh with rice and other cereals. We have already quoted the figures for the increasing imports of condensed milk in India. The scarcity of milk for infant feeding and the spread of the habit of tea drinking are largely responsible for the growing rate of its consumption. It is manufactured by heating the milk to 212 degrees F. to sterilize it and then carrying on the process of evaporation in a vacuum until it becomes thick. Considerable amounts of cane sugar are added to sweeten the milk. The keeping quality of condensed milk, which has a sugar content of not less than 40 per cent, is undoubtedly an advantage, especially in Indian climatic conditions. But the continued use of condensed milk, especially in infant feeding, may lead to gastro-intestinal disturbances and also to rickets. It is deficient in vitamin C and owing to the presence of excessive sugar its other nutritive constituents are 'unbalanced'.

Milk powder is usually prepared by drying good clean milk in a very thin layer at a high temperature on a revolving drum and then reducing the crusts into powder. The temperature used in the process determines the extent to which the nutritive constituents in milk are affected, but it is found there is no great loss in proteins, carbohydrates, fats, and fat-soluble vitamin A—provided great care is taken in handling the milk. The moisture content of milk powder should not exceed 5 per cent in order to safeguard against bacterial decomposition or fermentation. No ingredients should be added to the milk used for the purpose. Milk powders are usually made from whole milk and from half-skimmed milk; but where the fully skimmed milk is likely to go to waste, it should certainly be used for making milk powder. In this form, milk may be made available to the areas in India where the supply of whole milk is scarce or the distribution of fresh skimmed milk difficult. Milk powder is

The chemical composition of the edible portion of some of the common fish in Bengal is given below:

TABLE IX

Chemical Composition of Some Bengal Fish

	Protein	*Fat*	*Mineral Salts*
Rohi	18·35	7·56	1·42
Magoor	19·49	0·50	1·30
Koi (*Anabas scanderes*)	17·73	0·42	1·06
Mango Fish	16·76	4·12	0·83
Tengra	17·28	0·30	1·15
Bhetki	16·26	4·12	0·84
Hilsa	14·85	9·23	0·95

The digestibility of fish depends largely on its fat content, which varies from less than 1 per cent to more than 12 per cent. Fish containing less than 2 per cent of fat are known as lean fish and are more easily digested. They vary greatly in vitamin value, the fat fish being very good sources of vitamins A and D. Since fish store fat in their livers, the oils obtained from these contain a high vitamin potency. Although systematic research has not as yet been undertaken to determine the sources and content of vitamins in Indian fish, the livers of rohit (*Labeo rohita*), chitol (*Notopterous chitol*), vetki (*Late calcurifer*), and mrigal (*Cirrhina mrigala*) are found to contain vitamin A, and the liver oils of some of these have a vitamin potency as high as the famous cod-liver oil.

Fish are extremely perishable. Even at a temperature of 32 degrees F. fermenting action cannot be checked. Since the means and methods of insuring good preservation are not usually within the reach of fishermen, the supply during the seasons of big catch is often allowed to run to wanton waste. The problem is, however, solved by various scientific processes of drying and canning and also by refrigeration. The preservation of fishery products has become an important industry in the United States of America and several European countries, and recently Japan with her extensive fisheries has entered the field. The industry is strictly supervised by the State authorities and produces a clean high-grade product. To a large extent the natural flavour of different kinds of fish is preserved and canned products do not undergo appreciable deterioration in any climate.

tissue. Hess has shown[60] that the yolk has also considerable anti-rachitic properties and therefore its therapeutic value in rickets is much greater even than that of milk. But eggs and milk go well in combination; for they supplement each other. The egg deteriorates if it is not carefully handled and kept fresh by storing at proper temperatures. Various methods have been devised in the materially advanced countries of the western world for reducing the loss of market eggs, chiefly by the improvement of transport and storage. Dried and frozen eggs are extensively used in the Western bakeries.

(*c*) *Fish*

Fish is an excellent source of protein and also contains certain valuable inorganic substances such as phosphorus and iodine. Although its protein content is less than that of meat, it is more fully absorbed than any other animal food. Sea fish are more palatable than river fish but both are easily digestible and nourishing and provide good sources of iodine. The ratio of calcium to phosphorus content is usually high in fish.

Several species of mullet and pumfret, seer, hilsa (Indian salmon), mackerel, whiting, bombay duck, and various kinds of mango-fish (*Polyenmus*) are familiar examples of edible fish available in Indian waters. Among the freshwater edible fish, the Carp family (*Cyprinidae*) offers many varieties, of which the rohu (*Labeo rohita*) the catla (*Catla buchanani*) and the mrigal (*Cirrhina mrigala*) are well known to those who live in the Gangetic valley. In the estuaries (e.g. the Sunderbans) the rivers and creeks teem with delicious varieties of bekti (*Late calcurifer*) and mullet; in the hill-streams we have trout. Then there are various species of perch which are prized for the delicacy of their taste.

There is no great difference in the nutritive value of fresh and salt-water fish. While Indian rivers have great fishing value, the tropical seas contain almost inconceivable quantities of edible fish; but all these potentially rich resources have not as yet been utilized for supplying fish to those in India who have no prejudices against this invaluable source of good protein and easily digestible fat. It is noteworthy that fishermen are usually healthy and have a better physique than those of the same social class pursuing other occupations.

drawn from the vegetable kingdom lies in their richness in protective nutrients, their comparatively low cost as sources of energy and the roughage which they provide. All vegetables are low in fat; while most of them supply carbohydrates, their protein content varies in accordance with their type and form.

Vegetable foods may be classified under six groups, namely: (*a*) Leaf and flower vegetables; (*b*) Stems and bulbs; (*c*) Roots and tubers; (*d*) Fruit-vegetables; (*e*) Seeds; and (*f*) Fruits and nuts. Consideration of some of the characteristic nutritive values of each of these groups will enable us to assign it a proper place in a planned dietary. Roots, tubers, and seeds resemble each other in the sense that they are rich in starchy substances but relatively poor in other essential nutrients; on the other hand, leaves of plants contain abundant vitamins and inorganic constituents.

It is found that 'in both vegetable and animal tissues the most actively functioning part possesses the vitamins'. The leaves which contain most chlorophyl are richest in these substances and also supply a considerable amount of inorganic elements such as calcium, phosphorus, iron. Owing to their being alkalinic in reaction, leaves are helpful in maintaining acid-base equilibrium in the body. These properties vary, however, in accordance with the age and growth conditions of the leaf. Thin leaves, for example, are comparatively richer in vitamins and inorganic constituents than thick ones, while leafy vegetables grown in poor soils are also poor in these substances. Season, soil conditions, methods of cultivation, varieties —all these factors determine, to a great extent, the composition of foods of vegetable origin.

(*a*) *Leaf and Flower Vegetables*

Various kinds of spinach enter into the dietaries of all communities in India; but the supply is so precarious that the poorer classes whose high-grain diets require a liberal amount of leafy vegetables have to be satisfied with small quantities. And yet the sources of leafy vegetables are abundant throughout India and their supply can be increased if proper care is given to their cultivation. Recent investigations into the nutritive value of some of the common and inexpensive vegetables show that they possess high nutritive value as good sources of

But, important as the industry of fishery is in all those countries where the protein content of usual diets is low, no systematic attempts have as yet been made in India to apply scientific methods to fish culture. Fishing and the fish trade are left in the hands of an illiterate, poor, and extremely conservative section of the community, and consequently the methods adopted in exploiting the resources of Indian fisheries are crude and wasteful.

(d) Meat

Meat—the edible portion of animals—has entered into human dietaries chiefly because of the concentrated forms in which proteins and fats are readily available in it. It contains over 20 per cent of protein with a variable amount of fat ranging approximately from 2 to 8 per cent. A great portion of meat protein furnishes in liberal measure the amino-acids which are essential for tissue building.

Mutton, beef, goat's flesh, poultry, and game are the main sources of meat in India. While beef is extensively used by the Moslem and other non-Hindu communities, mutton and goat's flesh are largely consumed by the Hindus brought up in a non-vegetarian tradition. The quality of meat depends upon the breed and the nutritional state of the animal. Since no care is taken to develop the livestock, most meats in India are thin, tough, and poor in fat content as well as in the quality of proteins. Mutton and goat's flesh are prized because of the higher content of fat and better assimilated proteins.

There are many varieties of game birds in India which are esteemed as a source of wholesome food and the treatises on Hindu medicine recommend them especially for invalids. The meat of game birds does not differ in nutritive quality from that of other meats but it is not rich in fats nor is it easily digestible. Poultry farming is undeveloped and therefore the kind of chicken usually sold in Indian markets is scarcely fit for human consumption.

Foods of Vegetable Origin

We now turn to some of the principal sources of vegetable foods available* in India. The dietary value of foodstuffs

* For botanical names of plants, see Appendix IV.

values are recognized and garlic is recommended as a very powerful restorative tonic.

Stems of various plants are used as vegetables in India. While they provide a certain amount of carbohydrates and roughage, the protective nutrients are generally lost in the process of cooking. Beansprouts are rich in vitamin C, and as they are easily cooked, the nutrient is not destroyed in the process. They are extensively used by the Chinese and might well be introduced into Indian dietaries which are deficient in vitamin C.

(*c*) *Roots and Tubers*

This group of vegetables is rich in carbohydrates. Potato constitutes one of the staple foods in most countries, and has become popular since its introduction into India. It contains about 18 to 20 per cent carbohydrate but only 2 per cent protein; but recent experiments in Cambridge and elsewhere have shown that this small quantity of protein is of high biological value. The chief food value of potatoes lies, however, in the availability of easily digestible starch; but the nutritive properties of this universal tuber deteriorate if proper care is not taken in the selection of varieties, manuring, and cultivation. The sweet potato is rich in sugar, hence the Sanskrit name *sakarkanda*. It is one of the root-crops which are easily grown in India and may be used during famine as a substitute for cereals. There are several varieties of yam (vernacular: *kham alu*) grown in India but the ones which yield small-sized roots are the most valuable.

Among this group of vegetables we should include the much-neglected taro, which yields starch as good as potato: but both protein and starch content is high. There is no reason why its cultivation should not be encouraged in th[illegible]

national dish *Poi* is prepared from its corm and flour made from dried taro is much used in the West Indies. Its petioles and leaves may also be used as greens by boiling in a solution of sodium carbonate to destroy the acridity.

Perhaps the most nutritious root vegetable is the carrot. It is rich in inorganic substances, especially calcium, contains a fair

vitamins and inorganic constituents such as calcium, iron, etc. Only a few of these leafy vegetables need be mentioned here: *Amaranthus gageticus* (Lal sag), *Spinach oberacea* (Palong sag), *Bassela cardifolia* (Puin sag), *Murraya koenigii* (Curry leaves), *Ipomoca reptans* (Kalmi sag), *Moringa oleifera* (Drumstick leaves), etc.

The result of investigations at the Nutrition Research Laboratories at Coonoor shows that amaranthus and drumstick leaves, eagerly sought for by our rural population, are rich in vitamins, calcium, phosphorus, and iron. Cabbage combines well with other vegetables and is universally favoured for its flavour and digestibility. It is poor in proteins and fat but contains a fair amount of inorganic constituents and vitamin C. Tops of radish, beetroot, carrots, and onions are also used as leafy vegetables and their nutritive value is high enough to entitle them to be classified as protective foodstuffs because of vitamins and inorganic contents.

Great care is necessary in handling and cooking leafy vegetables if their nutritive value is to be adequately retained. They should be used as fresh as possible because leafy vegetables are susceptible to the loss of vitamin in storage. Ranganathan[61] found that in storage at room temperature, the loss of vitamin was 47 per cent after 24 hours and 95 per cent after 68 hours. Since in the raw state they have the advantage of less loss in essential nutrients, there is a growing concensus of opinion in the West in favour of uncooked leafy vegetables.

(*b*) *Stems and Bulbs*

Stems of the Indian spinach, celery, asparagus, rhubarb, beans, sprouts, and onions are a few representative vegetables that fall under this group. Onions and garlic are fairly rich in vitamin C but it is destroyed by the manner in which they are usually cooked in India. Owing to the strong flavour, they are used for seasoning Indian dishes. Recent investigations in the Kharkov Institute of Nutritional Research show that these bulbs have antiseptic action and reduce intestinal putrefaction, the best effect being obtained by combining 0·5 to 1 per cent garlic with meat preparations. The use of garlic in the dietary of patients suffering from tuberculosis is considered to be helpful. Both in Ayurvedic and Unani medicines, its therapeutic

starch content varying from 70 to 78 per cent. On account of their low protein and fat content, cereal foods must be supplemented by other kinds of foodstuffs containing these nutrients.

Rice is the chief article of diet of the inhabitants of Bengal, Assam, Bihar and Orissa, and Madras; and it is in these provinces that the physique and health of the population are particularly poor.

There are over four thousand varieties of rice grown in India. While their nutritive values differ widely according to the variety, locality, and season, especially in reference to protective food constituents, rice as a cereal is poor in protein and fat and also in calcium; its phosphatic content is, however, important. It supplies excellent carbohydrates consisting of starch, sugar, and dextrine, but a rice diet would be useless in normal circumstances unless it were enriched by the addition of foodstuffs supplying protein, fat, and inorganic constituents. The digestibility of rice depends largely on enzymic reactions and it is found that the higher index of digestibility of certain varieties is due to the presence of proteins, fat, and inorganic constituents in varying degrees. Storage under proper conditions improves the digestibility and taste of rice because of the conversion of starch into sugar.

Some of the common forms, somewhat allied to 'breakfast' foods of the West, in which rice is consumed are muri (puffed rice), khoi (roasted paddy), and chira (flattened rice). These are used by themselves with a little salt and pepper; or in combination with milk, curd, molasses, shredded coconut, etc. A mixture of fried grams and puffed rice usually constitutes a midday meal for our poorer class.

We have already discussed in Chapter Three the injurious effect of milling or polishing on the nutritive value of rice, especially on its vitamin B1 content. It is frequently asserted that the popularity of polished rice is due to its keeping qualities, its comparative freedom from the attack of weevils and its clean appearance. Nevertheless the use of this devitaminized rice should be discouraged as one of the means of correcting the grave deficiencies of the usual diet of a rice-eating population, which is already poor in essential nutrients.

Wheat is one of the main cereals in India, but it enters principally into the dietary of the people of two provinces, the United

amount of vitamin C and is rich in vitamin A. These nutrients, however, decrease in quantity with the maturity of the root. The sweet (*Halwa*) prepared from boiled carrot pulp, milk, and sugar in certain parts of India is nutritious and should be popularized.

Red beetroot have a high percentage of sugar and the leaves are rich in vitamins and inorganic substances. Whitebeet are cultivated in plantations for the manufacture of sugar.

(*d*) *Fruit Vegetables*

Brinjal, cucumber, gourd, lady's finger, papaya, tomato, and several other fruits are used as vegetables in Indian dietaries. Some of them (e.g. cucumber, papaya) also find a place among Indian fruits. Cucumber is often eaten raw and is regarded as having digestive properties. Chopra and Roy[62] traced the presence of a fairly strong ereptic enzyme in it. Various preparations are made with this favourite fruit. Sliced cucumber with curd is a popular recipe in Indian dietaries. It is one of the fruits which are included in the customary food-offerings to gods in the Hindu temples. Other members of the gourd family—pumpkin, squash, vegetable marrow in numerous varieties of all shapes, sizes, and colours—are eagerly sought after. Their nutritive value is low, but they provide a cheap and bulky source of vegetable food.

(*e*) *Seeds*

We now come to the most important source of foods derived from the vegetable world. Grains, furnished by certain cultivated annual plants, form the principal food of mankind. Unlike other foodstuffs, grains are non-perishable and consequently can be stored under proper conditions for long periods without deterioration.

For our purpose here the edible grains may be classified into two main groups, namely (i) cereals, (ii) legumes. There is a marked difference in the chemical composition of these two classes and their nutritive value in human dietaries lies in proper combination, cereals providing energy-bearing substances and legumes a certain amount of vegetable proteins.

(i) Cereals* are the richest source of carbohydrates, their

* Latin, *cerealis*, pertaining to Ceres, Goddess of Grains and Harvest.

TABLE X

Composition of Bran

Substance	*Wheat*	*Rice*
Proteins	16·4	19·0
Ether Extract	3·5	2·0
Carbohydrates	43·5	43·0
Inorganic substances	6·0	8·7
Fibre	18·0	10·0
Moisture	12·5	8·3

Rice bran is considered superior to that of wheat. A variety of bread, cakes, and pasties may be prepared with it. Its use should be encouraged in all regions afflicted with beri-beri. It is necessary, however, that bran should be fresh since it is likely to get bitter and rancid owing to the presence of a high percentage of proteins, fats, and water.

(ii) LEGUMES. The plants bearing peas, lentils, beans, vetch, and groundnuts belong to the botanical order leguminosae and their seeds are generally known as pulse. They are a valuable supplement to cereal diets as a cheap means of enriching them with an increased amount of protein. In the cereals, the protein content does not, as we have seen, exceed 12 per cent, but most of the pulse contain as much as 24 per cent. But since a high-percentage protein content is not a sole criterion of the value of foodstuffs, we have to consider the limitation of the availability of the proteins in the legumes. Legumin, which is the chief protein principle, may be classed as 'good', but owing to the cellulose content of these seeds, the protein is not available to the body as readily as that of animal origin. Certain kinds of pulse do not contain cystine, which is one of the important groups of amino-acids. On the other hand, the nutritive value of pigeon pea (*Cajanus indicus*) and of field pea (*Pisum arvense*) have been studied in the Research Institute at Conoor and they are found to be almost as good as casein. Peas are deficient in two amino-acid groups, namely, cystine and tryptophane.

Pulse are fairly rich in carbohydrates and contain a small amount of fat. They are not easily digested because of the amount and quality of cellulose which forms the bulk of their carbohydrate content. The large amount of hemicellulose, for

Provinces and Punjab, and their adjoining tracts. Its superiority over other grains is fully appreciated but on account of its high price its consumption is restricted, especially among those who need the nutritive substances derived from it. Its proteins are found chiefly in the glutenous portions, the inorganic and vitamin substances in the germ and bran. The flour obtained by grinding wheat-grains between millstones is called *Atta*, which is of course coarser than the highly milled products. *Atta* contains nearly twice the amount of protein that is obtainable in rice.

Millet is a small-seeded cereal. Jowar (*Sorghum vulgare*), bajra or cambu (*Pennisetum typhoideum*), ragi (*Elensine coracana*), and cholam (*Andropogon sorghum*) are some of the varieties grown in India and they are the staple grains of a great majority of the people. Compared to wheat and high-grade rice, these grains are coarse, inferior, and cheap: and if habitually consumed without adequate fresh vegetables, there appear pronounced symptoms of calcium deficiency. Ragi contains a high percentage of starch, but the digestibility and biological value of its proteins are superior to low-grade rice. The percentage of protein varies from 5 to 9 according to the variety and soil conditions. Sorghum, which is known as a poor man's grain, gains a respectable status in the estimation of a nutritionist when it is sprouted; for it then becomes a source of vitamins A and C. These minor cereals, as they are called, are eaten in the same way as rice and wheat. They are boiled, parched, ground, and often prepared as gruel in combination with milk or curd.

Bran has now received recognition from the scientific world as being a valuable part of the grain. It contains vitamins B1 and B2 and has a fair proportion of inorganic substances. Owing to its influence upon enzymatic action, bran has a special nutritive value.

The percentage composition of the bran of wheat and of rice is as follows:

TABLE XII*

Germinated Lentils as a Source of Vitamin C

Lentils	*Ascorbic Acid† as Estimated Chemically: Mg. per 100 g.*	
	Dry	*Sprouted*
Green mung	3·0	23·0–25·0
Black mung	2·7	10·5–18·7
Brown mung	2·3	11·7
Masur	3·0	15·0
Peas	2·7	9·1
Beans	1·25	14·2
White gram	3·0	7·3
Brown gram	2·5	7·8

Pulse are consumed in various forms; fried, roasted, soaked in water, germinated, and cooked, and in combination with cereals. A kind of water biscuit known as 'papad' is prepared from certain varieties of beans. Pulse are often preserved in the form of dried paste known as 'bari'. The paste is prepared by crushing soaked pulse to pulp which is then dried in the sun. The flour made from the varieties of split peas (dal) is extensively used for the preparation of sweets.

In view of the importance of the vegetable proteins supplied by these legumes, any agricultural policy designed to provide the nutritional requirement of our people cannot overlook the urgent need of improving the resources of leguminous crops in India.

We will here mention one special crop—groundnuts—which can substantially improve the average Indian dietary, especially because of the presence in it of certain nutrients in which cereals are deficient. Not only is its protein content high, but the group of amino-acids known as lysin makes groundnut an excellent food for milch cattle. Groundnut flour, it is suggested, can be mixed with wheat in the ratio of 1 to 4 for the

* Compiled from figures estimated by Dr. B. Ahmad, All-India Institute of Hygiene and Public Health, [illegible]

example, may lead to intestinal fermentation and flatulence. Pulse must be well boiled and thoroughly macerated in order to increase their digestibility.

Most of the legumes supply important inorganic constituents such as phosphorus and iron. Some varieties of lentils are particularly rich in iron. From the following table we get an idea of the food-values of a number of important pulse grown in India.

TABLE XI*

Percentage Composition of a Few Pulse Grown in India

Common Name	*Botanical Name*	*Protein*	*Fat*	*Carbohydrates*	*Inorganic Salts*
Black gram	Phaseolus mungo	23·8	1·5	55·5	3·4
Green gram	Phaseilus radiatus	24·0	1·5	56·0	3·5
Red gram	Cajanus indicus	21·5	1·8	57·0	3·5
Bengal gram	Cicar arietinum	19·2	2·9	61·5	2·4
Cow gram	Vigna catiang	22·5	0·5	52·0	3·1
Horse gram	Dolichos biflorus	22·0	1·3	53·5	3·4
Field bean (dried)	Dolichos lablab	24·5	1·7	58·5	3·2
Peas	Pisum sativum	20·5	1·4	56·5	2·4
Masur	Lens esculenta	24·0	0·5	58·2	2·4
Kheshari	Lathyrus sativum	25·1	0·9	57·4	2·9

Pulse, though not rich in vitamin A, are valued for their rich supply of vitamin B and germinated ones for vitamin C. The vitamin C content of legumes and lentils, though poor in a dry condition, is found to increase on germination, but to diminish if germination is allowed to proceed for any length of time. The value of germinated lentils as a source of vitamin is shown in the following table:

* Compiled from various sources.

form. For anaemic patients, fruits are more suitable than vegetables.

Several kinds of citrous fruits are grown in different parts of India, but their production and distribution are inadequately organized. Oranges (*sanatara, naringi, mandarin*), pomelo, lemon, and various species of limes are universally prized and furnish those protective food constituents in which the usual Indian dietaries are so deficient.

Among the pulpy fruits, *plantain* deserves special attention. It is one of the highly prized fruits in the tropics and there are several varieties cultivated throughout India. Fully ripe plantain is easily digested because in its green stage the starch content is converted into sugar and there is also a decrease in acids. Though poor in vitamins, it appears to have antiscorbutic and base-forming properties. Its use in diet-therapy shows that plantain is effective in reducing urinary acidity, and it is regarded as a 'valuable addition to the diet of young children, particularly those for whom a gain in weight is desirable'.[63] Certain varieties of plantain are used as a vegetable; the flowerheads (mocha) and the inner portion of the stem (thor) are also edible and enter largely into the dietaries of the people. Owing to its richness in carbohydrates (starch and sugar) plantain meal is prepared from unripe fruits. It is more nutritious than potatoes and easily digestible. On the banana plantations the meal is extensively used by the labourers.

Dates are rich in proteins, carbohydrates, and inorganic constituents, and are considered a 'concentrated food'. In recent years, they have become popular in the Western countries, which import large quantities from Egypt, Africa, and the Near East. In Iraq, dates are now mechanically cleaned, graded, and packed for export.

Nuts are a highly concentrated food with very little waste. Most of them are fairly rich in proteins and fats but generally poor in carbohydrates, though there are nuts like chestnuts and peanuts which contain a large amount. Nut proteins have a high biological value and compare favourably with meat and fish. They are therefore a palatable supplement to a diet poor in protein; but, on the other hand, a diet composed of cereals, legumes, tubers, fruits, and nuts 'may be balanced so far as chemical analysis can show but be defective in other respects'.

making of bread or biscuits. In the United States of America and in some European countries, though provided with abundant sources of animal proteins, 'peanut bread' and various other products manufactured with groundnut as the basic constituent have found a place in human nutrition.

But it is not surprising that so little attention has been paid to improving Indian dietaries by an extensive use of groundnut in varied forms. The demand for this legume, of great commercial value outside India, has greatly increased in recent years and India, being a debtor country, finds in this crop a valuable asset for her export trade. Before the War, our export to France alone came to no less than 35,000 tons per year. Under the stimulus of export demand, there has been a rapid increase in its cultivation: from about 93,000 tons in 1901, the output has reached the figure of nearly three million tons in thirty-five years. The internal consumption however remains low although its use in Indian dietaries, not merely in the form of little salted peanuts, would have corrected a great many nutritive deficiencies.

(*f*) *Fruits and Nuts*

Fruits fall within the category of protective foodstuffs because they contain inorganic salts and vitamins; but they are also valued on account of their base-forming properties. The protein and fat content is low but most fruits are rich in acid salts; and contrary to popular belief these lose the acid radicle by oxidation and are therefore helpful in maintaining the acid-base equilibrium in the system. The importance of the citrous fruits for the prevention and cure of scurvy has already been emphasized. Pomelo (*Batati lebu*) is even richer in vitamin C than lemon and orange. Among other fruits grown in India, pineapple, papaya, mango, leechi, tepari (*Physalis peruviana*), have high values of vitamin C.

Most of the juicy fruits contain readily assimilable glucose and they are very helpful in those cases where a supply of carbohydrates is necessary without putting much strain on the digestive organs. Pineapple or orange juice may be given to babies with beneficial results. The chief sugars in fruits are sucrose, glucose, and fructose. Grapes are exceedingly valuable as a food because they contain glucose in a readily assimilable

the date, the coconut, and the palmyra palms. Properly speaking, these palms are not cultivated but the aggregate areas under them are considerable and provide a source of cheap sugar supply. The yield of juice and the quality of jaggery or gur (its colour, degree, and form of crystals) depend upon the kind of palms, the soil conditions, and the season. The percentage of sucrose present in jaggery is approximately as follows:

Sources of Juice	*Percentage of Sucrose*
(1) Coconut	85
(2) Palmyra	82
(3) Sugar cane	70
(4) Date palm	55

If the manufacture of jaggery or gur from palm juices is developed on the lines of organized cottage industries, it would eventually free India from her dependence on sugar imports and mitigate the disadvantages inherent in the capitalist system of production, the mainspring of which is the motive of profit. What is more, it may substantially reduce the consumption of *toddy*, the fermented intoxicating beverage distilled from the palm juices. The policy of exemption from excise tax imposed on palm trees should therefore be extended over a wider area provided the juice tapped from them is used for the making of jaggery.

Perhaps the most ancient of all sources of sugar is *honey*, and it is the best form of concentrated sugar available to us. Its medicinal properties are well recognized, and Indians highly appreciate its value as an article of food. In the hilly tracts of the Punjab, the United Provinces, and Assam, honey is obtained as a wild product. Its production and sale are not organized and the scientific aspects of apiculture have so far received no attention from the State. Honey contains more fructose (40·5 per cent) than glucose (34·5 per cent) and its content of sucrose may be as low as 1·9 per cent. Its flavour is derived from the aromatic substances of the flowers from which it is drawn.

Fats

The need of fatty substances in our diet has already been emphasized. Of the sources of animal fats, we have already

The nutritive constituents of nuts are of special value to Indian dietaries and should be well utilized. Various kinds of nuts and almonds should be included in the dietary of adults, especially if good animal proteins are excluded from it. One distinct advantage of nut proteins over flesh foods is that they are free from toxic waste products. In *coconuts* we have a food of exceptional value, rich in both fats and carbohydrates. The liquid inside the shell prior to the maturity of the coconut provides a popular drink in India. The nut yields a nourishing oil and is extensively used in Indian dietaries.

Sugar

Sugar cane and the juices of the date, coconut, and palmyra palms are the chief sources of sugar in India but she has to import a large quantity of beet-sugar from Java to meet her internal demand.

Sugar is a form of readily available concentrated carbohydrates and consequently its food value is chiefly as an energy producer. In a sense it acts as a good stimulant but the tendency towards an excessive consumption should be checked since it can do as much harm to health as excess of alcohol.

It is a serious dietetic problem that the consumption of *refined* sugar, a product which has been deprived of important constituents present in its natural source, should be increasing at an exceedingly rapid rate in India. 'The wholly devitalized, demineralized, and devitaminized white sugar and its products' enter our markets and replace *jaggery* or *gur*. The latter are not altogether devoid of the inorganic constituents of the plant juices in the fresh state and are therefore more nutritious. *Gur* is easily digested and absorbed. The sugar of commerce is not a natural food. The practice of drinking freshly crushed sugar-cane juice, so common in India, is perhaps an example of the instinctive adoption of a means of correcting certain dietary deficiencies and should be encouraged. There are several varieties of edible sugar canes grown in India which are not available for the manufacture of sugar, and these are greatly enjoyed by the people as a source of a refreshing sweet juice.

Jaggery is prepared from sugar cane and juices tapped from

mentioned butter, cream, and ghee, which are particularly desirable because of their richness in vitamin A and their palatability. There is a prejudice attached to the use of other fats of animal origin such as lard, margarine, fish oil and liver oil in Indian dietaries. Mustard, linseed, sesame, groundnut, and coconut are some of the sources of edible vegetable fats on which the greater part of the Indian population depends for culinary purposes. Of these mustard oil is perhaps the most popular. It is expressed from three kinds of mustard seed, namely, *Brassica juncea* (Indian mustard); *Brassica dichotoma* (Indian rape); *Brassica campestris* (Indian colza). It is a common practice to adulterate the mustard oil with oils from niger, sesame, linseed, and other oil-bearing seeds, or even with cheap mineral oil. The difficulty in controlling the purity of mustard oil lies in the fact that it may be adulterated with 20 per cent or even more of these oils from adulterants and yet the saponification and iodine values will remain within the limits stipulated by the Pure Food Acts in India.

The oil expressed from the fruit of Mahua (*Bassia latifolia*) is largely used by the poorest inhabitants of Central India. Fresh coconut butter is an excellent edible fat but it is in the form of oil, extracted from the sliced coconut kernel, that a considerable quantity of the crop is consumed. Groundnut oil is another good source of vegetable fat which bears a close resemblance to olive oil in chemical and physical characteristics. There is no reason why its use should not be popularized in India.

From the nutritive point of view, we should note that most vegetable oils do not contain vitamin A; but red palm oil extracted from the fruit of *Elaeis guineensis*, grown in West Africa, Malaya, and Burma, is considered rich in vitamin A potency. Tests carried out in Nutrition Research Laboratories, Coonoor, show that samples of Malayan and Burmese red palm oil contain about 500γ of carotene per g., which is almost equal to the vitamin A content of good cod-liver oil. It has also been found[64] that proper mixtures of this oil with some of the common Indian vegetable oils would provide an excellent source of vitamin A. In view of the fact that most Indian dietaries are dangerously poor both in fat and vitamin A content, experiments for growing this palm in suitable parts of

India should now be taken in hand and further investigations should be made into its use for culinary purposes.

Food Adjuncts

(a) Salt and Condiments

Salt is an essential ingredient of food. It is indispensable for the purpose of maintaining the normal osmotic pressure in the tissues and fluids. It is found in the earth as rock salt and the richest salt-producing tracts in India lie to the north-west of the Indus, in Kashmir and Rajputana and in Sind; but nearly half the world supply comes from the sea.

A diet consisting largely of grains and similar starchy foodstuffs needs salt. While an excessive intake is not desirable, its shortage leads to mineral deficiency and consequential symptoms of ill-health. The rate and amount of perspiration under climatic conditions in India are more than that in the temperate zone and therefore the loss of salt has to be made good by its intake in our diet. The consumption in India varies from province to province and it is estimated that nearly 3 to 5 per cent of the income of the poor in India is spent on salt.

The tax on this essential component of our diet is a part of the fiscal system of the Government, and under the Government of India Act, 1935, salt tax is allotted to the Federation.* But all sections of Indian public opinion have persistently demanded that the Government monopoly in salt should be abolished. Not only on the grounds of increasing the burden of taxation on the poorer classes, but on the evidence of the incidence of disease caused by insufficient salt consumption, the Indian National Congress opposed the salt tax. 'A tax on salt is as undesirable from the biological point of view as would be an excise duty on wheat in England,' observes Haldane[65] in reference to salt tax in India. He says that it is, under the

* The revenue obtained from the taxation of this essential article of food is as follows:

	Rupees
1931–2	85,792,000
1932–3	100,736,000
1933–4	88,565,000
1934–5	80,001,000
1935–6	84,280,000

circumstances in India, 'quite clearly detrimental to the health of the people. No doubt its abolition would dry up an important source of revenue, but in a civilization where biological issues—questions of life and death—were regarded as equally important with economic issues this would not be thought a final objection. . . . The continuance of the salt tax is a biological argument for Swaraj.'

The practice of using savoury substances in human dietaries is of ancient origin. The extent of their use is probably determined by climatic conditions and the nature of foodstuffs. It is known that they influence salivary, gastric, and pancreatic secretions and may also deter to some degree the process of fermentation. Turmeric (*Curcuma longa*) acts as a carminative and adds colour to the cooking materials. Aniseed (*Pimpinella anisum*), cloves (*Eugemia caryophyllata*), fenugreek seeds (*Trigonella foenum-graecum*) are some of the spices which have medicinal properties. Excessive seasonings of food, as usually practised in Indian cooking and necessitated by the predominance of starchy food, have, however, deleterious effects both upon digestion and absorption. The high incidence of gastric ulcer and carcinoma in south India appears to be related to the excessive use of chillies.

Spices are obtained from various parts of trees and shrubs generally grown in the tropics. For example, black pepper is the dried, unripe seed of a climbing vine, while chillies are fruits of a plant; ginger is the underground stem of a reed-like plant and cinnamon is the bark from the young shoots of a tree; clove is the dried unopened flower bud of an evergreen plant and nutmeg is the fruit of another spice tree; caraway is the seed of a small plant, and so on.

As regards the nutritive values of spices, most of them contain inorganic substances such as iron, iodine, and calcium. Ginger is rich in starch and volatile oils, and is preserved by the addition of sugar and honey to the boiled roots. Chutney prepared fresh with a mixture of dhania (coriander) leaves or podina (*Mentha arvensis*) and green mango pulp or tamarind is a cheap source of vitamin C.

(*b*) *Tea and Coffee*

Perhaps the most important and widely used infusion of the

leaf-buds and leaves is tea, which is picked from the bush known as *Thea*. It was originally consumed in China more as a medicine than a beverage.

Tea obtained from the youngest leaf buds is called flowery pekoe and the fresh and tender leaves next the buds produce what is commercially known as orange pekoe because of their yellowish tint. Other grades depend upon the quality and age of leaves picked from the bush.

We may note here the difference between green and black teas. The former is prepared from the young leaves by roasting them soon after picking. It contains more tannic acid and volatile oil but less caffeine than black tea which is produced by submitting the leaves to a process of fermentation. The percentage of tannin is greater in black tea than in green tea.

Light tea has no deleterious effect upon general health if taken very moderately. It may even aid digestion; but its excessive consumption is harmful to a high degree. It causes cardiac irritability, stimulates gastro-intestinal action to the degree of interfering with the digestive processes and produces, according to a body of American investigators,[66] 'certain unmistakable nervous symptoms' if taken habitually in large quantities.

The infusion made from the bean of *coffea arabica*, roasted and then ground to powder, is another beverage which is highly prized by millions on account of its stimulating effect upon the nervous system. The pleasant aromatic flavour of coffee is derived from its volatile oil, coffeol.

Tea and coffee are used rather for what is described as 'a mild cerebral stimulation' than for their actual food value. They contain no substances which are essential for nutrition; nor can these beverages be regarded in a real sense as valuable food adjuncts.

(c) Drinks and Drugs

It is relevant to refer to the habitual use of alcoholic drinks and of various drugs in connection with the subject of health and nutrition, and we shall briefly state the nature and source of these intoxicants which are available for consumption in India.

We have seen that food is a substance which builds tissues,

furnishes energy, and preserves life. From its chemical composition it is evident that alcohol cannot function as a tissue-builder. The actual amount of energy derived from its consumption is small and generally promotes dissipation of heat. It is estimated that a glass of milk yields about 184 calories while the same quantity of good beer does not yield more than 168. The common belief that alcohol tends to develop any *permanent* increase in neuro-muscular activity is not supported by adequate evidence. It has, however, some stimulating value under conditions of great exhaustion.

From the nutritional point of view the consumption of alcohol tends to interfere with the normal process of combustion of other substances. Its effects upon undernourished bodies particularly or upon those who are suffering from disabilities incidental to malnutrition, may cause irreparable damage and aggravate the tendency to psycho-neurosis so common among the majority of our labouring class.

But the prevalence of alcoholic neuritis, delirium tremens, cirrhosis of the liver, and several other similar complaints among the upper and middle classes should warn us that the alcoholic drinks consisting largely of wines, whisky, brandy and various brands of liquors are wholly unsuitable to their physical constitution. Taking into consideration all the factors prevailing in the tropics, Sir John Megaw, who has had a long experience in the Indian Medical Service, came to the conclusion that the 'indigenous races of tropical countries should be discouraged from the use of alcohol in any circumstances'.

It must be said to the credit of our people that drinking has not become a national habit; nor do the people regard abstainers as cranks or faddists. On the contrary, to the vast majority of the unsophisticated, it is generally considered discreditable to become an addict to intoxicants and narcotics. That section of the upper and middle classes which has perceptibly acquired the habit of drinking would remain abstemious but for the influence of the European community, whose habits and traditions encourage them to regard the consumption of drinks as providing an occasion for social relationship between the Europeans and Indians.

The liquor traffic which affects our lower middle and poorer classes consists of two forms of alcoholic drink. *Country spirit*

(Arrak) distilled from fermented rice, millet, barley, mahua flower (*Bassia latifolia*) or molasses is largely consumed by the lower middle classes. It is more injurious than fermented liquors (toddy, crude beer, etc.) because the spirits contain a high percentage of ethyl alcohol, the toxic limit of which to the human system 'is more quickly reached and more easily exceeded'. According to Lieutenant-Colonel Chopra of the Indian Medical Service, even the excessive consumption of carefully brewed beer is less harmful than that of strong country liquors. Reports of the Excise Administration in India, however, show a tendency to increasing consumption of country spirit,* and in the provinces where, owing to economic depression in recent years, the present level of its consumption 'is lower than it should be', it is the policy of the Government to bring it to the desired level in the interest of the Excise Revenue.†

Toddy is prepared by fermenting juice obtained from the spadix of the fan palm, date, and coconut trees. It does not contain more than 5 per cent of alcohol and is fairly rich in vitamins B1, B2, and C. Fermented liquors, somewhat akin to beer, are also obtained from cereals but the alcoholic content of most of these beverages is low. Owing to the presence of yeast, they also provide vitamins to the ill-balanced diet of the poor.

The aboriginal races and the poorer classes of our population regard toddy both as a natural food and a cheap form of stimulant. 'Toddy fills our bellies but distilled liquor does not,' was the reply given to me by a Santal villager. The Nagas in Assam never drink milk but use in its place rice-beer called Zu, which is somewhat like a thick gruel. It is taken as a part of their monotonous dietary. To most of the aboriginal and backward races, the use of fermented liquors is also a part of their religious and social festivals. While excessive drinking is a feature of such festive occasions, Chopra thinks that 'gross instances of producing motiveless drunkenness from country beers, corresponding to the excessive consumption of alcohol in the Western countries are very rare'. He further observes

* Average consumption per 100 of the population in 1932–3 was 1·12 (L.P. gallons) and it rose to 1·52 in 1933–4.

† See Appendix V.

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that the areas where such beers are consumed are remarkably free from many of the deficiency diseases.

Prohibition of the use of toddy without finding an effective substitute for vitamin B1 may be detrimental to the health of the people whose dietaries are usually deficient in this food factor. Bray[67] gives us an account of what happened in Nauru,* an island in the Pacific Ocean, as a result of forbidding by an Ordinance the consumption of toddy made from fermented palm juice. Beri-beri made its appearance especially among nursing mothers, and infant mortality rose to 50 per cent. The alarming situation necessitated the withdrawal of this Ordinance and within a short time the infant mortality fell to 7 per cent. The moral of this example from a biological point of view is that prohibition of toddy can be successful only if it is followed by the use of foodstuffs which would meet vitamin B1 deficiency.

In any case, the task of controlling and finally abolishing the consumption of toddy and other forms of fermented liquor has to be approached with some caution as their suppression may lead to the drinking of stronger spirits such as are distilled from *Mowha* and cereals. Perhaps the most effective means of bringing under control this form of liquor traffic would be to find some wholesome substitute. In South India, a simple beverage made of water sweetened with jaggery and flavoured with pepper or tamarind is regarded as a 'sacred drink'. To the addicts, the various kinds of non-aerated drinks (sherbets) prepared with fruit juices may not appeal at the first instance, but if the prohibition campaign is based upon the physiological effect of alcohol upon health, we believe that it should not be difficult to make our unsophisticated masses realize the deleterious consequences of drinking habits. Now that the National Congress is determined to safeguard the health and morals of the people by declaring prohibition throughout India, it is to be hoped that the movement will have the active support of all workers in the field of medical and nutritional research.

That in consequence of the excise policy of the Government, the problem of prohibition in India is confronted with stupendous difficulties may be realized from their attitude towards the campaign for suppressing the drink traffic. They urge with

* *Governed by Australia under a mandate from the League of Nations.*

confidence the continuance of their policy because the traffic yields a substantial revenue which the Government cannot raise from other sources. But if one could estimate in terms of rupees, annas, and pies the loss of health, physique, and economic efficiency consequent upon the drinking habit, the figures would certainly exceed the sum of 15 crores* which the Government derive from this degrading form of taxation. And one should remember that the total money extracted annually by the traffic exceeds 62 crores.

From the point of view of food supply, the prohibition is of great importance to agricultural economy, since a considerable quantity of cereals are now used in the production of liquors. In Assam, for example, nearly 25 per cent of rice is thus consumed. The utilization of juices obtained from palm trees for the manufacture of jaggery would go a long way to meet the demand for sugar, the consumption of which, as the experience in the United States showed, is bound to increase with the success of the prohibition campaign.

Opium is the dried juice of a poppy, *Papaver somniferum* and owes its soporific properties to a number of alkaloids of which morphine is the chief. The plant is not indigenous to India; it was introduced by the Moslem traders about the ninth century and its cultivation and use received much encouragement from the Moghuls. During their time the poppy capsules were extensively used to prepare a beverage known as Koknar, and, according to Chopra, this decoction is still drunk in parts of the Punjab and Rajputana. The cultivation of the poppy, the manufacture of opium, and its sale are organized as a Government monopoly. For over two centuries a flourishing trade in opium existed between India and China. In conformity with their undertaking to the League of Nations, the Government of India decided in 1926 to reduce exports to Far Eastern countries 'for other than medical and scientific purposes' by 10 per cent annually.

As regards the consumption of excise opium in India, the figures show a considerable decline; but the morphine habit is spreading. Some of the chief areas of poppy cultivation are situated in the Indian States and there the opium habit shows no tendency to decrease. Not only in consideration of its

* 1 crore=£750,000.

deleterious effects upon health and well-being should the opium habit be cured, but the fact that it demoralizes the addict and greatly reduces his economic efficiency should concern the feudal lords and industrial capitalists. The use of soya-bean lecithin, a substance derived from the milk expressed from the bean, is found to be efficacious in the treatment of opium addicts. It has been demonstrated that daily doses of 60 to 90 grains of this substance for a few weeks produce 'spontaneous gradual discontinuity' in the use of opium by the addict. Dr. Wen-Chao Ma reports[68] that the substance is administered orally after meals and it is easily assimilated, and that 'the treatment reduces opium tolerance but is not accompanied by any distressing symptoms of withdrawal'.

There is an urgent need for special institutions for the treatment of opium addicts in India and it is hoped that the matter of their cure will be approached with sympathy and understanding; for in many instances the habit is formed among the undernourished agricultural labourers, coolies in the tea-gardens, and the workers in the mining areas, because opium stimulates physical energy and keeps their ill-clad body warm in the cold season. The excessive consumption of inferior rice tends to the craving for opium and narcotics.

Indian Hemp (*Cannabis sativa*) alone yields three forms of drugs which, on account of their low prices, are largely used by the masses. The preparation obtained from the dried leaves of the plant is known as *bhang*, that of the oleo-resinous exudate as *charas*, and that of the flowering top as *ganja*. These drugs have a greater hold upon the addicts than opium, one of the reasons being their close association with religio-social ceremonies. Among certain communities indulgence in them is regarded as a symbol of 'divine intoxication' and they are included in offerings in the temples as being 'foods of the gods'!

Another drug, not manufactured in India but whose consumption is increasing especially in north India, is cocaine. It is an alkaloid found in the leaves of the coca, 'the divine plant of the Incas'. It acts as a stimulant to the whole central nervous system and its addicts seem to have a greater control over hunger and to undergo much physical exertion without fatigue. It is for this effect perhaps that the cocaine habit tends to become so popular among the Indian labourers.

CHAPTER SIX

Diets of the Peoples of India

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There is an incantation in *Rig-veda** which runs as follows: 'Now will I sing triumphantly of food that maintains strength, by whose stimulating power *Trta* rent *Vrta* limb from limb. Whatever morsel we consume from waters or from plants of earth, O *Soma*, wax thou fat thereby.' Information regarding the dietaries and dietetic habits of the various Indian communities and of individuals at different ages in different occupations is meagre and unsatisfactory. We have nothing like a proper diet survey. Those who have been so far responsible for the welfare of the masses have no intimate knowledge of the various types of food and dietetic preferences and peculiarities of the Indian communities; but from the depressing state of general health and the growing incidence of deficiency diseases, it is clear that the nutrition of the greater part of our population does not satisfy even the marginal requirements. Whatever morsel they consume, it does not seem to make them 'wax fat'.

In this chapter we shall attempt to describe the main features of the usual dietaries of different Indian communities and to collate such data as are available to show the extent and nature of nutritional deficiencies so prevalent throughout India.

Hindu Concepts of Diet

From the Vedic literature we get an idea of Hindu dietary. It consisted mainly of grains such as rice (Vrihi), barley (Yava), varieties of beans and lentils, milk and milk-products, and

* *Rig-veda*, 1–87.

fruits. Various preparations of porridge and gruel* are recommended, and they are prepared with grains cooked with lentils or milk. A Hindu meal is not complete without some kind of sweets which are usually prepared with milk, rice, and sugar; or various milk-products and sugar. According to *Vatsyayana*, a normal diet should consist of rice, wheat, barley, pulse, vegetables, milk, and sweets. The comprehensive term for all that we consume is 'Anna'.

In the *Susruta Samhita* wholesome diet is described as being 'that kind of food which can nourish the body, gladden the heart, invigorate the system, maintain the bodily strength, increase the appetite and vitality, improve the memory and increase the energy and span of life'. The attainment of all these beneficial effects is what the modern dietitian desires by his advocacy of 'balanced diet'.

The classification of food in Sanskrit and Pali literature is based on the forms in which it is taken. Buddhist monks divided food into two groups, namely cooked and soft food; and uncooked and hard food. Others divided food according to its physical characteristics such as solid, liquid, food taken by licking, and food that is chewed. But with the development of knowledge of the production and taste of foodstuffs, the classifications were made more systematic. Thus we have six forms of food—sweet, sour, salty, bitter, astringent, and pungent. Finally, we have the elaborate therapeutic values of foodstuffs based on what is known in Hindu medicine as *Rasas*. All substances of vegetable, animal, and mineral origin are classified strictly according to the predominant taste and their physiological action formed the basis of controlling diseases.† It was held that tastes and flavour affect the digestive mechanism and should be regarded as a reliable guide in the choice of food. A Hindu feast prepared in the orthodox style must of course be vegetarian. In southern India for example, it would include the *Navarasams*, that is, nine tastes, beginning with something bitter and ending with something sweet.

tables and fruits, the use of germinated pulse, the fondness for milk and milk-products, and the consumption of sweets are the main features of a Hindu dietary; and they have not substantially altered in the march of time. The reason for this is not far to seek. The development of transport, free social intercourse among different communities, fresh knowledge of foodstuffs, and consequent enterprises relating to their supply, and, above all, the rise in the standard of living—all these circumstances, which facilitated to a great extent the dietary changes among the Western communities, did not arise in India. Food instinct, sentiment, tradition, custom, and prejudice dominated in the choice of diet.

And yet, owing to the geographical circumstances of the Peninsula which determined the kind and amount of foods available, there are certain common features in the dietaries of the various races and communities. The basis of all diets is cereals, pulse, vegetables, fruits, and milk.

It is true that the food rites and rituals which have evolved around different stages of economic life, from the pastoral to the settled agricultural, have left their mark on the bad dietary customs and habits of our peoples. They have a tenacious preference for diets determined by religious bias and are usually averse to any change. Thus the influence of communal groups and their pressure often functions as a deterrent to the choice of new or tabooed foods. The non-vegetarian Hindus will not eat fowl and fowl's eggs but have no objection to duck, geese, and wild birds (e.g. plover, teal, etc.). The dislike of fowl may possibly be traced to its use in ceremonial propitiation by the aboriginal tribes. Even the cult of vegetarianism may have originated from the impulse to distinguish the 'Aryan' mode of living from that of the other clans which used animals as totemistic symbols. Be that as it may, a considerable section of the Hindu communities, especially the higher caste, are vegetarians.

There are elaborate rules prohibiting consumption of various articles of diet on certain days of the lunar month. For example, if patol (*Trichosanthes dioica*) is eaten on the third day of the moon, the consumer will have the bad luck of increasing the number of his enemies; radish on the fourth day would mean loss of wealth; coconut on the eighth day would make the

consumer a dunce; beans on the eleventh day would lead to sinful acts; gourd and allied vegetables on the thirteenth day might result in loss of one's son; if lentils are taken on the fourteenth day of the moon, you will have chronic disease, and so on. These rather amusing rules are carefully recorded in the Hindu Calendar and one wonders what could be the reason for such restrictions. They may have been designed as an attempt to ensure stable conditions of food supply by regulating the distribution of edible fruits and vegetables.

That the great majority of our people are conservative in regard to the choice of foods and do not easily take to anything foreign is undoubtedly true; but we have no reason to believe that they are incapable of changing their food habits. There are of course extreme cases of conservatism. The *Namburi Brahamins* in Malabar—a sect which surpasses all other Hindu communities in orthodoxy—would not, for example, eat potato or tomato because they are of foreign origin!

The increasing consumption of wheat among the rice-eating people, the popularity of potato, the use of refined sugar, and of condensed milk are some of the instances which tend to show that the conservatism of the Indian does not offer a serious obstacle to effecting a change in his dietary. If he is made to realize the value of different kinds of foodstuffs which are physiologically beneficial to him, and if the means of procuring them are within his grasp, he will falsify the common assertion that owing to his religious bias the task of improving the state of his nutrition is hopeless.

Moslem Concepts

While the Moslem dietaries are comparatively free from the numerous restrictions imposed upon the Hindus, there are taboos in the use of certain foods, which derive a religious sanction from the early days of Islam. The flesh of those animals 'that are cloven-footed, those that chew the cud' is lawful food; but, to quote the words of the Koran, 'that which dieth of itself, and blood and swine's flesh, and that over which any other name than that of God hath been invoked, is forbidden to you'. Fish found dead in water are prohibited but if their death occurs after they are caught it is equivalent to

ritual slaughter. The emphasis laid upon ritual slaughter is probably a sanitary code. It is interesting to note that the custom of regarding animals killed for food as a sacrifice is of ancient origin and may be compared with the rites by which certain classes of the Hindus seek to remove the taboo of flesh-eating. The Sesasht Brahmins of the Deccan eat only the meat of a sacrificed goat, and in Bengal the priests of the Hindu temples sell the flesh of sacrificed goats.

Having to draw upon the common supply of foodstuffs there is no fundamental difference in the dietaries of the two great Indian communities except that the Moslems habitually take meat. A difference, however, exists in the methods of food preparations. Moslem cooking delights in the extensive use of spices which include a liberal supply of onions, garlic, and ginger; and most of the dishes are rich in *ghee*. Rice is prepared in various ways in combination with meat, eggs, pulse, nuts, almonds, etc. Wheat is taken in the form of bread both leavened and unleavened, but yeast is not used in baking bread. One of the popular kinds of leavened bread is known as *Baquirkhani*, named after its inventor, and *Shirmal* is sweetened bread made of flour kneaded with milk. There are several kinds of unleavened bread baked on an earthern or iron plate prepared with various combinations of butter, mincemeat, coconut kernels, poppy seed, and pulse. Gram flour and pulse meal are also used for the making of bread and different sorts of cakes.

Milk and milk-products enter largely into the Moslem dietary. Curd and buttermilk are often used in combination with flour of pulse (*Phaseolus radiatus*) and with fruit-vegetables like cucumber, brinjal, etc. Of the varieties of sweetmeats, *halwa* made of cream of wheat, butter, and sugar, is perhaps the favourite dish. Sweets of all kinds prepared from wheat, rice, and gram flours in combination with milk-casein and sugar are used by all Indian communities. Various forms of spiced savoury are particularly favoured by our working class.

Dietary Habits

Our principal meals are two, one at midday and the other at sunset. An account of the manner of serving meals in a Hindu household (possibly of Bengal) recorded by a Chinese

traveller in the ninth century may be of interest. He writes: 'The first course is a small piece or two of ginger with a little salt. It is followed by some form of rice preparation, and lentil soup (Dal) is served with hot butter sauce as flavouring. Then are served fruits and cakes (Pistakas). After the meal is finished tooth-pick and water are supplied to the guests for cleaning the mouth. Sometimes perfumed paste is given to rub the hands with before washing in order to make them fragrant and clean. Finally some betel-nuts, nutmegs with cloves, etc., are distributed. This helps to make the mouth fragrant, to digest the food, and remove the phlegm.'

Broadly speaking, there has been no substantial change in this manner of serving meals or of eating foods. The use of knives, forks, and spoons is confined to a very small section of the people but the custom of eating food without their aid should not be discouraged. Among other advantages, the habit provides an automatic safeguard against the risk of eating hot food and drinking scalding hot liquids which may cause a *constant irritation of the stomach.*

The habit of chewing betel leaf (pan)* is common among our people. Its chief constituents are grated areca nut, unslaked lime, catachu, cloves, and other spices, rolled within a betel leaf. The combination is astringent and is thought to aid digestion, but clinical observations tend to support the view that the excessive use of *pan* may lead to buccal cancer. At any rate, it affects the mucous membrane of the mouth and interferes with normal secretions.

Over-indulgence in spiced foods and in sweets, irregular meal times, eating too fast, are some of the habits which *seriously affect the nutritional processes.* Even those who are in the fortunate position of being able to choose their diet as they like, show crass ignorance concerning healthy dietary habits. The diet of the well-to-do and educated is very often characterized by an excess of seasonings; nor do they seem to realize that any habitual excess of food, over and above what is really needed to maintain health, is not only uneconomical but positively harmful. In a previous chapter we have stated some of the consequences of overfeeding. The observation of a

* *Piper betle:* a perennial dioecious creeper, cultivated for the sake of its leaves.

Chinese writer that one-fourth of the food consumed by the rich goes to nourish them and three-fourths to kill them is not an exaggerated statement. The ill-health and diseases from which well-to-do Indians suffer may indeed be traced not only to the inadequacy of this or that nutrient substance but also to their dietary habits.

As regards wastage, no one interested in the food problem of the country can view with equanimity what goes on in the average household of the upper and middle classes in India. On ceremonial occasions the varieties and amounts of food are far in excess of actual requirements; course after course is served with the idea of maintaining a false standard of prestige rather than of satisfying the needs of the guest. This orgy of over-indulgence, this gluttony, this form of grotesque dietary habit should no longer be tolerated, and it is to be hoped that in our social festivities a simple diet will come into vogue.

There are also other sources of wastage in transport, storage, marketing, and preparation of foodstuffs. A food conservation campaign throughout India is no less important than a campaign for food production. Even in the kitchen the waste is not inconsiderable and it arises mainly from ignorance in handling foodstuffs as well as from the methods by which the risks of contamination are avoided.

Food practices are regulated by complicated caste rules among the orthodox Hindu communities. There are also various forms of food taboos many of which appear to be associated with hygienic considerations. They lay down what kinds of food one should take, in whose company a meal should be eaten, the nature of the vessels which should be used for eating, drinking, and cooking, and a host of other rules.

Cooking

Most foodstuffs are cooked in order to make them more digestible and palatable. Tissues in meat and cellulose substances in vegetables have to be softened, retaining at the same time their nutritive value and palatability. Various methods, such as boiling, steaming, baking, and frying, should therefore be so adjusted to the type of food materials that over-cooking

may not deprive them of much of their nutrient substances. The problems of culinary art are thus fundamentally related to nutrition, and should engage our attention if substantial improvement in our dietaries is desired.

But this business of cooking the Hindus leave to a professional class known as *Thakur*, and the Moslem to *Baburchi*. While in the cooking of a variety of preparations out of simple ingredients, Indian cooks exhibit a commendable skill, they do not possess even a rudimentary knowledge of what happens to the nutritive substances of the foodstuffs handled by them. They cling tenaciously to traditional methods of cooking and serve their preparations time and again without any change in taste, flavour, and appearance. Vegetables are over-cooked; gruel of cooked rice, which contains vitamin B1 and certain mineral salts, is thrown away; chapatis are often served under-baked; and most of the preparations are highly seasoned with condiments and spices. In order to increase the palatability of food, they often destroy its digestibility.

Our educated communities show little interest in the problems of culinary art. In our Press and educational institutions we do not discuss how desirable changes may be brought about in the field of nutrition by rational methods of food preparation. Our girls are not given any training in cookery except what they learn from traditional sources—and no initiative has so far been taken by our public health services to give direction to the people how best they could prepare meals with economy and at the same time provide a balanced diet. The compilation of cookery books for the guidance of the different income groups in India should be taken in hand by appropriate organizations. The training in proper cooking is as important as the dissemination of the knowledge of nutritive constituents.

It is time that attention was given also to the location of kitchens, their general sanitary conditions, and the supply of appropriate cooking utensils. An interesting reference is found in Sanskrit where we are told that 'the kitchen should always be on the south side and should be regarded as the most sacred part of the house'. In orthodox Hindu households, a part of the kitchen is used for the worship of deities—a custom which may have originated from the motive of enforcing the habit of cleanliness. Nevertheless, very much remains to be

done in the way of improving the sanitary conditions of our average kitchen.

Then there is the problem of fuel. For the preparation of most of our dishes, slow fires are suitable. Charcoal has been and still is a chief article of fuel, although in urban areas, coal is becoming popular. The practice of burning dried cowdung —that invaluable farmyard manure so essential for the maintenance of the productivity of the soil—arises from the scarcity of cheap fuel. The tragedy is that the villager is fully aware of the folly of using cowdung as fuel but knows not how to save it for manure.

Regional Characteristics of Indian Dietaries

Since there are great variations in physique and development among the races and communities living in different regions of India, a short account of the usual dietary in each area may be of interest. That these variations depend upon various factors such as racial habits, modes of life, religious customs, climatic conditions, type of husbandry, availability of foodstuffs, etc. is obvious; but with the information at present available, we must confine ourselves to general descriptions of these regional diets. It should, however, be borne in mind that human nutrition is to a large extent guided by economic considerations and that the prevalence of undernourishment and malnutrition is a socio-economic phenomenon.

For our purpose we may divide India into six regional divisions, namely, Gangetic Delta, Upper Ganges Valley, Indus Valley, Deccan Plateau, Eastern Coast, and Western Coast.

(1) *Gangetic Delta*

The Presidency of Bengal falls within an area which is interlaced with several great rivers and their tributaries. It is perhaps the foremost rice-growing region of the world. Oilseeds, pulse, and sugar cane are the other important food crops grown in this tract.

The staple food of the people is rice, chiefly parboiled. Pulse, vegetables, fish, and various kinds of sweet preparations enter into the usual Bengali dietary. Owing to the availability of fish in east Bengal, the quality of diet is better than that of the

western part of the province. Mustard oil which is extensively used in cooking is the main source of fat and only those families not living in want can afford ghee or butter. The average yield per diem from the diminutive milch cow of the province is so low that there is a scarcity of milk. In many households, babies are fed with rice or barley gruel. According to Sir John Megaw's enquiry, only 22 per cent of the people of the province can be regarded as being well nourished.

The daily food of the majority is thus characterized by excessive quantities of carbohydrates consumed in the form of rice and *gur* or sugar; it is deficient in fat of biological value and in protein. The average intake of protein hardly exceeds two ounces per day. The diet is poor in protective nutrients, a defect which has much influence on the incidence of several ailments common in the province.

(2) *The Upper Ganges Valley*

This tract embraces a considerable part of the United Provinces. Rice, wheat, millet, oilseeds, and sugar cane are the staple food crops grown but they are dependent upon monsoon and irrigation.

Chapatis made of wheat flour or other cereals (according to the means of the consumer), legume soup, vegetables, curd, sweets, and fruits are the principal items in the dietary of the people. Inferior qualities of rice (e.g. red rice) take the place of wheat when its price is high. The poor generally have one meal in the evening and eat parched cereals or germinated gram during the day. During the season the Mahua flower is largely consumed by the indigent population.

Cow milk is beyond the means of the majority of the population but skimmed milk, curd, and goat's milk are often used as substitutes. One important feature of the dietary in this area is the proportion of green leafy vegetables, which is higher than that of other parts of India.

(3) *The Indus Valley*

The upper Indus valley is called the Punjab and the lower, Sind. The chief food crops of the region are wheat, millet, and sugar cane, grown under an extensive system of irriga-

tion. The communities living in these provinces are reputed to possess fine physique and stamina, and they are largely represented in the Indian Army. The main characteristics of the dietaries of these north Indian peoples may be illustrated by a description of the diet of the Sikhs, which is neither simple nor inexpensive in comparison to that of other Indian communities.

MacCarrison's investigation into the various diets of Indian peoples led him to the conclusion that the Sikh régime was the most nutritious of all those he examined. This diet consists largely of freshly ground wholemeal wheat made into a form of unleavened bread called *chapatis*, legumes, fresh vegetables, and milk-products. The vegetables are usually cooked in clarified butter and the milk-products include buttermilk, curd, and soft cheese. The Sikhs do not take beef, but various kinds of animal food enter into their dietaries. It is obvious that a mixed diet of this nature is not likely to be deficient in 'good proteins', and the liberal quantity of milk and fresh vegetables consumed by the average Sikh family ensures the supply of other protective food substances. The Sikh children are usually breast-fed for about two and a half years and are then given diluted fresh milk. Towards the end of the period of suckling, they are given curdled milk—a sort of junket.

The dietaries of the other fighting races of India such as Jats, Dogras, and Rajputs are very similar to the Sikh régime with the exception of the Pathan diet. The indigent population among these races, however, lives on inferior cereals and has to eke out an existence with a much less varied diet. The Pathans are fond of meat and consume it more than the other races. Among the Rajputs the diets of those inhabiting the western part of the Central States are superior to those usually consumed by their compatriots domiciled in the United Provinces. They are not so rigid in the observance of caste regulations and are hence more amenable to changes of dietary habit.

(4) *Deccan Plateau*

This area is situated in the centre of the Indian peninsula and is characterized by a wide variation in physiographical and climatic conditions. Of the main cereals grown, millet and rice are largely consumed by the people. The varieties of pulse

grown are of inferior quality and they are frequently consumed in mixtures with grains.

Wheat is cultivated in the northern section of the plateau. The proportion of pulse in the dietary is usually small and vegetables, especially leafy varieties, are rarely consumed. Milk consumption is even lower than the minimum in other parts of India. The use of fruit is not generally in vogue. Sesame and linseed oils are largely used in cooking and the consumption of *ghee* is a rare luxury even among the middle classes.

(5) *Eastern Coast*

We are now in the Presidency of Madras. Rice, millet, pulse, and sugar cane are the main foodstuffs. The diet consists chiefly of parboiled rice, millet, pulse, soup (dhal), vegetables, curd, and tamarind water. Excepting those belonging to the lower social scale, the peoples are generally vegetarians, and many live on coarse rice seasoned with salt and chillies, and a small quantity of vegetables. In the average dietaries of communities living in this region, 'protective' foods are represented only by vegetable proteins furnished by some kind of legume soup (dhal) and by a small quantity of non-leafy vegetables. Green leafy vegetables and fruits are absent from the usual dietary. The proportion of milk and milk-products in the diet is extremely low. Babies are weaned on rice-water and children are fed on cereals and a few coarse vegetables.

(6) *Western Coast*

Various kinds of millet, rice, wheat, oilseeds, and sugar cane are the main food crops grown in this zone; a certain portion of the cultivated area is given to fodder crops.

The staple diet of the vast majority consists of chapatis made of millet with a scanty supply of vegetables and dhal. Even in the 'dairy zones', many families use considerably less milk and milk-products than they did a few years ago. 'Congee', that is the surplus water obtained in cooking rice, is given to babies as a substitute for milk. Curd is a favourite product among the Mahrattas and enters into the dietary of the poor in a very diluted form. In recent years there has been an increase in the consumption of fruits.

The Cult of Vegetarianism

From our outlines of Indian dietaries it should be apparent that the great majority of our peoples are vegetarians although a diet exclusively drawn from the products of the plant world is confined to a small minority. We have seen that milk and milk-products are included in the dietaries even of those who have an aversion to foods of animal origin. Some take eggs but no meat and no fish, and some abstain from meat but not from fish.

In Europe and America, the theory and practice of vegetarianism is confined to a small number of individuals, often invalids or faddists, and to the experimental investigation of physiologists. This is not the case in India, where the question of vegetarian diet is bound up with the ethical principles embodied in the doctrine of *Ahimsa,* which enjoins the moral of reverence for all living things. Manu observes: 'Meat can never be obtained without injury to living creatures, and injury to sentient beings is detrimental to the attainment of heavenly bliss.' The idea that the abstinence from animal food assists man in his efforts to attain holiness by enabling him to control animal passions encouraged the cult of vegetarianism which became a part of the discipline of Buddhistic monasticism.* But the precepts of Buddha did not lay stress upon food-taboos as being essential for securing immunity from animalism. 'It is not the eating of flesh', declared this prophet of rationalism, 'that defiles a man, but the doing of evil deeds.'

It may well be doubted, however, whether the origin of a custom so widespread is to be found in religious sanction alone. To the Aryan-speaking settlers meat was not a prohibited article of food. On the contrary, they regarded it as a stimulating sustenance and prescribed that pregnant women should eat meat 'with a view to strengthening the unborn child'.† It is very probable that the prohibition of meat originally had a purely practical and healthful purpose. Meat decomposes with extreme rapidity and is far more susceptible than most other

* The practice of vegetarianism was common among the Orphic Societies in Egypt and among the Neo-Pythagoreans. The Chinese Buddhists took religious vows of temporary vegetarianism during their pilgrimage to a sacred mountain.

† Flesh, according to the *Satapatha Brahmana,* is the best of foods.

foodstuffs to external infection from flies, cockroaches, and other germ-carrying insects. This disadvantage is especially great in a warm climate like that of India. Moreover, certain diseases may be communicated to man through the consumption of the meat of infected animals. Even in modern times such objections have been raised, for example, by the well-known French vegetarian Jean Nussbaum who observed that 'both physiologically and psychologically man is ill-adapted to the consumption of such highly putrifactive material as flesh foods'. And a dim realization of the ill-effects of diseased meat is not uncommon even among primitive races. In the distant past considerations of this sort may have first induced the Indian people to renounce the eating of meat, and religion later added dogmatic sanction to a practice enjoined by the requirements of health.

However this may be, vegetarianism is in fact practised by millions of the Indian people, whether from reasons of health, inclination, necessity or religious prejudice. And the question that presents itself is, how far is this practice compatible with the optimum nutrition suggested by the results of modern investigation? The problem can be reduced in general terms to a question of amino-acids. That certain amino-acids are, as we have seen in Chapter Three, essential to the human organism for the purpose of building tissue is one of the fundamental discoveries of nutritional science. The proteins of animal products—meat, fish, eggs, milk—contain the essential amino-acids in greater quantity and of better quality than do vegetables or fruits. Animal proteins have a higher digestive utilization and biological value than vegetable proteins.

Thus the physiological arguments afford a strong *a priori* reason for preferring a diet which includes animal foods to one which does not. On the other hand, it seems equally certain that a *purely* vegetarian diet *can* support life in a state of good health. Records of endurance exhibited by vegetarians on a spare diet of fruits and vegetables, the bodily vigour and longevity of some of them, and the low incidence of such ailments such as Bright's disease, and high blood pressure, contradict the assertion that a non-flesh diet necessarily has debilitating effects upon the human body.

There are, however, two objections to a purely vegetarian

diet. In the first place, although it is not impossible to construct a vegetarian diet which would provide all the necessary proteins in the required amounts, yet to do so would require a certain care and skill—an amount of skill and knowledge not in general possessed by the average housewife. The truth is that when we examine the *actual* vegetarian diets of the vast majority of the Indian people we find that they are in fact lacking in the essential proteins, or at best that they are only on the margin of sufficiency. Where rice is the staple article of diet it is most unlikely that the protein requirements will be adequately supplied, for the protein of rice is very exceptionally poor. The second objection is perhaps less serious, namely, that a vegetarian diet which succeeds in providing sufficient proteins is likely to be excessively bulky. The poorer the constituents are in proteins the bulkier will the diet have to be. And a very bulky diet is not generally considered palatable.

But these considerations do not necessarily imply that *meat* must needs be included in the diet in order to insure optimum nutrition. There is a tendency in the Western world to adopt this view, but it is not in our opinion a necessary consequence of the latest researches on proteins. It has been shown by Terroine that the addition of comparatively small amounts of the proteins of high biological value contained in animal foods to the less good proteins of cereals, legumes, and other vegetables has the effect of raising the biological value of the whole protein mixture to a level as high or higher than that of the good proteins. Now the proteins of milk and of eggs—especially of milk—are among the best which exist. It should be possible therefore, without much difficulty, to devise diets which, though the bulk of them be composed of vegetable foods, would, by the addition of sufficient quantities of milk and eggs, supply all the proteins required for optimum nutrition. Long ago Rubner pointed out that the staple diet of the robust and healthy Bavarian peasant consisting of bread, milk, milk-products (e.g. cheese), and a liberal supply of vegetables was not deficient in proteins. During the War the International Allied Food Commission came to the conclusion that the proteins of meat could be replaced by eggs, milk, and milk-products and that there was no need for alarm at the reduction of meat supply.

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We need not further recapitulate here the discussion of 'supplementing' which we have dealt with at length in Chapter Three; we wish merely to point out the conclusions which we think should be drawn from that discussion with regard to the question of Indian diets. These conclusions may be very briefly summed up as follows: a *purely* vegetarian diet, while it *may* provide adequate proteins by including, for example, soya-beans, nuts, etc., in large quantities, is always open to the danger that it may not. Such a diet should therefore be discouraged. Where, for any reason, it is not possible to introduce foods of animal origin into the diet, care should be taken that the proteins be derived, not from one source alone, but from a variety of foodstuffs; where possible, however, foods of animal origin should be consumed. There is no need to include meat and fish in the diet, though if there is no economic or religious objection to their inclusion it should be borne in mind that their proteins are of the best. Milk and eggs, and milk above all, added to an otherwise vegetarian diet, will in all cases ensure an adequate supply of the best proteins. The first object, therefore, of those who concern themselves with the improvement of Indian nutrition should be to encourage by every possible means the consumption of milk. When the time comes when every Indian household is a large consumer of milk and its derivatives and eggs, no further improvement in diet will be necessary, in so far, at least, as proteins are concerned.

The Diet of Schoolchildren

A proper diet survey of our schoolchildren has not been attempted; but we have seen in Chapter Five that the Reports of the Public Health Departments record a high incidence of eye diseases (e.g. xerophthalmia and keratomalacia), stomatis, unhealthy skin (e.g. phrynoderma), and other symptoms of malnutrition among them. While the cause of these maladies may be traced to defective development or pathological conditions resulting from infectious and other diseases, there is no doubt that dietary deficiencies must be regarded as a predominating factor in the appalling state of health of a large proportion of schoolchildren in India.

We are indebted to Dr. W. R. Aykroyd and his colleagues

for initiating investigations into the state of nutrition of school children in South India. Over 1,900 children between the ages of 6 and 17 in three towns were examined with results which show that 'a large percentage of children are suffering from malnutrition due to deficient diet'.[69] Ordinarily the diet of children of school-going age throughout India consists of cereals, a small quantity of vegetables and thin soup (dhal) made of legumes, and perhaps a little diluted curd. Among the non-vegetarians, there may be a bit of fish and meat. The usual diet contains a disproportionate amount of carbohydrates and is extremely deficient in proteins, fat, and vitamins. The zest with which children indulge in feasts of meat suggests 'protein starvation'.

Not only is the food thus provided absurd in its lack of proportion between essential food constituents, but the absurdity becomes a positive menace to the health of the growing children when excessive seasonings with spices are used in its preparation. Milk, which is of paramount importance, is inadequate or absent; and their diet does not usually include fresh or dried fruits.

The science of nutrition has shown beyond doubt that adequate and proper feeding during the formative period is essential for the health and well-being of the child, and that if it suffers from undernutrition and malnutrition, the consequent retardation of both physical growth and mental development cannot be made good at a later stage. Not only does a growing child require more food than an adult in proportion to his body-weight, but there must be an adequate supply of protective food constituents in his normal diet. What the proportion should be, has to be determined by careful investigation. It is estimated that the diet should contain for every unit of protein, one unit of fat and five of carbohydrates and that it should provide fruits and vegetables as a safeguard against vitamin deficiencies.

As a result of recent experiments in Russia carried out on an extensive scale on the nutrition of schoolchildren, it is found that in their average diet the protein level need not exceed 13 per cent, and the fat content may vary from 18 to 22 per cent according to age. Children from 8 to 12 years require more fat than those from 13 to 16 years.

Similar experiments are being conducted in those countries where the feeding of schoolchildren is included among the duties of the public health services, and it is imperative that this all-important problem should now be a part of the constructive programme of the Indian Ministries. They may well begin the task by instituting a system of strict supervision of the nutrition of children in residential hostels, orphanages, and similar institutions. Partly because of the low level of expenditure allotted to food and partly because of the ignorance of the authorities in regard to the dietary needs of the inmates placed in their care, institutional feeding in India does not provide even the barest minimum of essential nutrients for the growing child.

As an illustration of the shortcomings of the dietary of pupils in a number of hostels under the supervision of district school authorities in India we append here a table composed from data supplied in a note published by the Office of the Director of Public Health in Bihar and Orissa.

TABLE XIII

A Statement of Various Hostel Diets in Bihar and Orissa*

Name of Hostels Attached to the High English Schools	*Community*	*Rate per Month (in rupees)* †	*Quantity of Uncooked Food per Head per Day (in ounces)*	*Calories*
		Rs. as. p.		
Monghyr Hostel	Hindu	10 0 0	26·5	2,232
Monghyr Hostel	Moslem	8 0 0	25·5	2,092
Chapra Hostel	Hindu	8 8 0	28	1,976
Hazaribagh Hostel	Hindu	7 8 0	29	2,230
Purnhia Hostel	Moslem	7 8 0	26	1,908
Purnhia Hostel	Hindu	7 0 0	27	1,796
Southal Hostel	Hindu	7 0 0	28	2,158
Muzaffarpur Hostel	Hindu	7 0 0	24	1,944
Northbrook Hostel Darbhanga	Hindu	7 0 0	31	2,318
Raghunathpur Hostel	Hindu	5 10 0	31	2,520
Average	—	7 8 0	27·7	2,124

* Notes by Jahar Lal Das, the office of the Director of Public Health, Bihar and Orissa, 1928.

† One rupee equals 1s. 6d.





VIII. The dry and atrophic skin (Phrynoderma) in a man aged 20 also suffering from Keratomalacia.

By kind permission of Dr W. R. Ackroyd.

[illegible]
tion in diet; seasonal fruits do not form a part of the dietary of these children and milk is excluded because 'of its cost and also of its availability'. And all this in a province which is known as the most fertile region in India!

The situation in other parts of India is no better. The growth of about 1,000 children attending the primary schools in Bombay was recently studied by an association interested in dietary reform. It was found that the pupils were nearly 22 per cent below the standard weight and their growth with reference to age and height furnished enough evidence to show that they were undernourished. In their investigations covering some thirty residential hostels for schoolchildren in south India, Aykroyd and Krishnan found[70] that the diets supplied were generally of low nutritive value and that the incidence of angular stomatitis, phrynoderma, and xerophthalmia—the conspicuous symptoms of malnutrition—were common among a considerable percentage of the children living in these institutions. The Students' Welfare Committee of Calcutta reported not long ago that out of every ten students six were definitely suffering from some effects of malnutrition, two were complete wrecks, and only two physically fit.

These are not isolated instances; poor physique, impaired vigour, gastro-intestinal disturbances, low resistance to infections and other pronounced symptoms of malnutrition—all these features are common among schoolchildren throughout a great part of India. Even in those 'ideal' institutions which claim to aim at the creation of a healthy body and healthy mind, the diet provided to the inmates is far below their nutritional requirements. Is it any wonder that these institutions succeed in producing both physical and psychical morbidity rather than positive health?

But the problem of improving the state of nutrition of our schoolchildren is not so intractable as it appears. It has assumed such serious proportions chiefly because of the complacency of our educated classes and of the incompetence of those responsible for the government of the country. It now requires a new orientation of the entire educational system and a

close co-operation with agriculture and small-scale industries. In most instances, the level of expenditure for food in homes or in hostels is kept, of necessity, so low that any improvement in diet schedules is impossible. The commendable efforts to suggest cheap balanced diets costing less than five rupees per month may not remove the conspicuous deficiency of 'good' proteins and essential vitamins. In our judgement, the true method for the improvement of institutional feeding is to be found in providing a fruit and vegetable garden, which should be an indispensable part of a residential hostel for schoolchildren. In its initial stage, such a farm may require a subsidy or block grant from the State, but it should be able to run eventually on a self-supporting basis—supplying a substantial quota of foodstuffs for the hostel. Running the farm would also offer ample opportunities for providing instructive manual work for the inmates of the hostel. As regards the feeding of day-school children belonging to indigent families, the responsibility must rest with the State.

The difficulty in the way of cooking or preparing food at the school may be solved by adopting the system practised in Norway, where the diet of schoolchildren is supplemented by the regular provision of free or cheap meals. As a result of successful experiments carried out some years ago by Professor Schiotz at Oslo, the system suggested by him has drawn the attention of public health departments in European countries for many years past. The originality of the system lies in the fact that the main objective aimed at is to ensure that the children may be protected against any form of vitamin or mineral deficiency which might be found in their home diets. The 'Oslo breakfast' as it is called, consisting of milk, scones made of whole wheat or rye flour, a piece of cheese, an orange or apple or a raw carrot, is served half an hour before the opening of classes. Not only has a considerable improvement in the physique of the children been noticeable as a result of this form of supplementary feeding, but parents themselves are enthusiastic over the success of the experiment.

The suggestion that the necessary steps should be taken by the State without delay to ensure adequate and proper nutrition to malnourished schoolchildren in India appears to have been received with approval in high official quarters. In the

course of an eloquent speech, on the occasion of inaugurat a scheme for providing milk in schools in Simla, Lord Linl gow, the Viceroy of India, observed: 'What indeed is the of spending public funds on objects such as education, well schemes and the like if the people have not the health vigour of mind and body to take full advantage of them and enjoy them? What indeed can we hope from a political c stitution unless we apply ourselves without delay and v persistence, vision, and courage to the improvement of physical constitution of the common run of man and wom For, in truth, the response of the individual to the opportuni of life, whether economic, cultural or political, is inevita inadequate in the absence of that vigour and ambition and that joy in life which belong to the possession of a healthy balanced mind linked to a healthy body.'

The ideal to which the Viceroy draws our attention is t of optimum health which can only be attained by the provis of an optimum standard of diet including both the ener bearing and protective foods. And this standard must be p vided during the school years as well as in early childho What satisfactory results have been achieved by encourag a liberal consumption of milk and other protective food shown in the experience of those countries where the w being of the young generation is regarded as an obligatio the State. If definite measures are now to be adopted in In for providing for the nutritional needs of schoolchildren, i to be hoped that they will be made an integral part of educational system. The supply of safe and abundant mill the army has been assured by setting up well-organized m tary dairies, and there is no reason why the milk-in-scho scheme for India should not also be placed upon such a secu basis. The provision of milk for schoolchildren, nursing expectant mothers, and for infants requires concerted act on the part of the State and the informed public, and I beli that the time is propitious for the establishment of a num of special dairies throughout India, which would both prov a fundamental basis for nutritional development and ren real assistance to the dairy industry.

The Diet of the Industrial Worker

Let us now inquire into the worker's diet. Rising at dawn he usually takes a hasty snack of cold, stale rice or a few pieces of *chapati*; and consequently long before the hour provided by the factory management he feels the need of the morsel of food he is able to secure from all sorts of food vendors and cheap restaurants. 'The haphazard and unsatisfactory ways in which the Indian worker feeds, during his working hours,' observes the Royal Commission on Indian Labour, 'is one cause of his slackness and half-hearted working.' Then, the period of recess allowed is far too short for his midday meal and no suitable accommodation is provided for him to take it in any reasonable comfort. He is therefore tempted to resort to the cheap eating places where the food served is of doubtful quality and is highly seasoned with spices, and it is here he usually contracts the habit of drinking liquor.

In order to assess the state of nutrition of the industrial workers, we have to set up a standard of their minimum dietary requirements, and also to calculate its cost. In their memorandum to the Royal Commission on Labour in India, the Bombay Textile Labour Union, in arguing the case for a minimum wage, based their estimates of expenditure on food upon the cost of the first six of the nine articles listed in the prison diet at the prices ruling in December 1929. The figure arrived at was Rs.* 5, 4 annas, 2 pies per adult male. Of course the estimate varies with the nature of the industry and the province where it is located. Concluding from the enquiry of the conditions of labour of the workers in the jute industry in Bengal, Chowdbury[71] calculates the average expenditure on food per equivalent adult male in the families with an income of Rs. 20 to 30 per month, as Rs. 5-12-3. Allowing for the discrepancies in these two estimates, mainly due to the variations in prices, we may accept for the purpose of comparison the standard of expenditure on food allowed in the prisons of Bombay. It is, however, necessary to bear in mind the circumstances under which the worker is able to purchase the foodstuffs with this sum of Rs. 5-4-2. Usually he depends on credit which petty grocers allow him, but for this favour the prices of his purchases

* 1 Rupee=1s. 6d.

are raised at least by 10 per cent. There are also other disadvantages in dealing with small shops, where retail prices are, let us note, higher than those in the organized markets on whose figures the prison statistics are based, and here among the small vendors the practice of food adulteration is very common.

Before we turn to some family budgets of our industrial workers, we may set out in a table a quantitative estimate of daily food consumption per adult male worker as against that of a prisoner.

TABLE XIV

Showing the comparative daily consumption of food per adult male in the homes of free industrial workers and in the prisons of Bombay

Items of Foodstuffs	*Industrial Workers*		*Indian Convicts in the Prisons of Bombay*	
	Bombay Textile Industry	*Madras Textile Industry*	*Light Labour*	*Hard Labour*
	lb.	*lb.*	*lb.*	*lb.*
Cereals	1·29	1·13	1·38	1·5
Pulse	·09	·07	·21	·27
Meat	·03	—	·04	·04
Salt	·04	·05	·03	·03
Oils	·02	·03	·03	·03
Food Adjuncts	·07	·09	—	—
Total	1·54	1·37	1·69	1·87

As regards the qualitative value of the prison diet, its gross nutrient content is estimated as follows: proteins 7·1, fat 2·8, carbohydrates 34·6 ounces per day.

Since the appointment of the Royal Commission on Labour in India, several enquiries into the worker's family budget have been instituted by Provincial Governments. Investigations are, however, not sufficiently comprehensive in the sense that they do not include details in regard to the state of nutrition of our industrial workers. Here we shall attempt to analyse certain relevant data obtained by these enquiries, confining ourselves

to those income groups which are officially recognized as being truly representative of the Indian working class.

In the first place, we take the three income groups of the working class families, namely: (1) below Rs. 30; (2) between Rs. 30–40; (3) between Rs. 40–50. Families whose income levels exceed Rs. 50 are not included because the Royal Commission on Labour regarded them as being outside the proper category of the Indian working class.

Secondly, within these groups we ascertain the average composition of the family in terms of adult males, adult women, and children and calculate the number of equivalent adult males in each group for the purpose of estimating the food requirement of the family. The expression 'equivalent adult male' needs explanation. Physiologists hold the view that a woman normally requires less food than a man, and the food requirements of children would of course vary with their age. Consequently it is necessary to lay down a scale of relative requirements of men, women, and children. One such scale which is widely used is suggested by Cathcart and Murray[72] and is recognized by the British Medical Association. The scale is as follows: If we take the needs in terms of food of an adult male as 1, a family would require food in the following proportions:

Adult male	1
Adult women	0·83
Child 10 to 14 years	0·83
Child 6 to 10 years	0·7
Child 1 to 6 years	0·5

Thus a family consisting of a man, a woman, and a child in each age group would require as much food as 3·86 adult males. Since the ages of the children are not mentioned in the budget estimates, we have to rely upon an average age approximating the child as being equal to ·68 of an adult male. Thirdly, the average expenditure of a family on food per month within a given income group is divided by the average number of equivalent adult males per family in that group. This would show the average food expenditure per month per equivalent adult male for the income group. Lastly, we calculate as nearly as possible the cost of food at the time of the budget enquiry for an adult male based on the standard of

the prison diet of Bombay, to which we have already referred.

The results thus obtained may be summarized in the following tables:

TABLE XV

Summary of average food expenditure of Industrial Workers

(*b*) Textile workers in Sholapur (based on 623 family budgets)

Income Groups	*Number of Families*	*Families: Percentage of Total*	*Average Monthly Expenditure on Food per Family*	*Average Number of Equivalent Adult Males*	*Expenditure on food per Equivalent Adult Males*
			Rs. as. p.		*Rs. as. p.*
Below Rs. 30	180	20·88	12 9 5	2 64	3 14 8
Rs. 30–Rs. 40	297	34·45	16 0 3	2·72	5 14 3
Rs. 40–Rs. 50	385	44·67	19 6 5	2·94	4 6 1

(*a*) Textile workers in Bombay (based on 862 family budgets)

			Rs. as. p.		*Rs. as. p.*
Below Rs. 30	207	29·7	13 5 1	2·92	4 13 6
Rs. 30–Rs. 40	231	33·1	16 14 8	3·64	4 7 7
Rs. 40–Rs. 50	185	46·5	20 4 4	3 99	5 7 3

(*c*) Textile workers in Ahmedabad (based on 548 family budgets)

			Rs. as. p.		*Rs. as. p.*
Below Rs. 30	146	25·8	14 14 0	2·71	4 3 2
Rs. 30–Rs. 40	182	32·2	18 13 0	2·9	6 7 9
Rs. 40–Rs. 50	220	39 0	22 10 6	3 25	6 3 3

(*d*) Textile workers in Madras (based on 73 family budgets)

			Rs. as. p.		*Rs. as. p.*
Below Rs. 30	26	32·9	16 1 7	3·89	4 2 2
Rs. 30–Rs. 40	24	30·4	10 19 11	4·93	3 15 11
Rs. 40–Rs. 50	23	29·1	25 4 7	6·05	4 2 10

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In scrutinizing these budget estimates, it should be remembered that they cover only a portion of Indian labour, for the lowest wage-earning groups are omitted; nor do they include the unskilled labour usually recruited through the labour contractors. The estimates themselves may be regarded as being inadequate for the purpose of drawing any definite conclusions. And yet they are sufficiently indicative of the state of nutrition of our working class. Indeed, it is impossible to avoid the general impression that over 60 per cent of them are underfed and that the percentage would show a great increase if all classes of labour were taken into consideration.

The family budget enquiries do not give us any information about the quality of the working-class diets. That their nature differs with region, religious observance, caste, and income is obvious; but on the whole, the diets which can be procured within the limit of the average expenditure on food per working class family resemble each other in composition and show similar deficiencies. They are low in proteins especially of high biological value and absurdly deficient in fat. The intake of milk and milk-products, and of adequate quantities of proper vegetables, is far below any dietary standard which may be regarded as balanced. The symptoms of physical ailments in consequence of an inadequate supply of vitamins A and D and calcium are markedly present among the bulk of the Indian working class.

In a memorandum submitted by medical authorities to the Royal Commission on Indian Labour, it was pointed out that the usual diet available to the bulk of industrial labour was not balanced and altogether inadequate in energy value. 'It is', states the memorandum, 'too bulky; it contains a very small amount of milk, butter, and animal fats and consequently does not give any appreciable power of endurance and resistance. Up to 25 per cent of the food calories should be from fat in a perfect diet. In the case of the working classes in Bombay city, however, 91·6 per cent of the calories are derived from cereals and pulse. Besides this, the diet does not provide enough vitamins or accessory food factors.' Even rice, which is, as we have seen, poor in proteins, is so prepared for consumption that its nutritive value is greatly impaired. The grain allowance given in some mills and factories as compensation for low wages does

not in any way improve the quality of the labourer's diet.

Dr. Margaret Balfour's investigation[73] into the diet of women workers in Bombay shows that they do not receive on an average more than 2,121 calories, and of the essential nutrient constituents in their usual diet, there is a marked deficiency in fat. In order to understand the actual state of nutrition of these women industrial workers, it must be remembered that the burden of household duties in the midst of a most depressing environment falls on them, and that their standard of dietary should be as high as that required for hard work.

The inevitable consequences of living on an inadequate and ill-balanced diet are reflected in the physique of the workers as well as in their efficiency. Here is a table composed from the memorandum of the Government of the Central Provinces to the Royal Commission on Labour.

TABLE XVI

Showing Comparative Body-weight of Spinner in Mills and Prisoner in Jails

Provinces	*Average Weight of Spinner*	*Average Weight of Prisoner*	*Difference*
Bombay	102·9	112·12	10·3
Central Provinces	100·92	110·45	9·53
Burma	117·14	125·70	8·56
United Provinces	107·01	115·08	8·07
Bengal	107·93	115·05	7·12
Eastern Bengal & Assam	108·00	110·85	2·84
Punjab	113·08	115·05	1·97
Madras	113·64	114·38	0·75

It is a matter of common sense that in order to attain any high standard of efficiency in industrial production, the health and well-being of workers must be the primary factor. In India a male weaver tends on an average less than two looms as against 5·5 by a woman in Japan. A cursory examination of our entire productive system whether agricultural or industrial, would show that it is both inefficient and insufficient, and it can never stand the strain of the demands put upon it by any increase of population and by the economic exigencies of the

In scrutinizing these budget estimates, it should be remembered that they cover only a portion of Indian labour, for the lowest wage-earning groups are omitted; nor do they include the unskilled labour usually recruited through the labour contractors. The estimates themselves may be regarded as being inadequate for the purpose of drawing any definite conclusions. And yet they are sufficiently indicative of the state of nutrition of our working class. Indeed, it is impossible to avoid the general impression that over 60 per cent of them are underfed and that the percentage would show a great increase if all classes of labour were taken into consideration.

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they could ascertain, 60 per cent of workers were in receipt of wages of not more than 1s. per day in the highest instance, scaling down as low as 7d. to 9d. for men and 3d. to 7d. in the case of women and children. Upon these miserable pittances the workers are expected to keep body and soul together and labour throughout the whole working day (often in a vitiated atmosphere and under most irksome conditions) which on the average cannot be less than one of ten hours.'

In Cawnpore, nearly 70 per cent of the wage-earners have an income below Rs. 30, and the dock labourers do not average more than Rs. 20, per month. As for the mining industry, the conditions of employment, the irregular attendance and the character of the labour employed are such that no reliable estimate of income and expenditure on food can be easily calculated; but the average daily earnings of workers (in English equivalents) in seven coalfields in British India during 1918–31 were: overmen and sirdahs, 2s. 1d.; miners, 1s. 4½d.;* loaders, 1s. 1½d.; skilled labourers, 1s. 4d.; unskilled, 10d.; females, 8d. (Many women earn only 4½d. per day.) Referring to the income of the labouring class in the Central Provinces and Berar, Colonel Wilson observed: 'their wages are so low that they can hardly afford two square meals a day, even by spending on them the whole of what they earn daily'.

That the low rate of wages seriously affects the health and nutrition of dependent children is obvious. On discovering that the third non-working child of a labourer in a tea-garden in Assam did not survive, its proprietors decided to pay 30 per cent extra wages to a coolie who had three non-working children. This enhancement had the effect of reducing the death-rate of children in that plantation.

Under the existing economic system, the most practical method of ensuring adequate and proper nutrition to the working class is to establish a legal minimum wage. Such a minimum wage should be calculated on the basis of a careful estimate of the necessary requirements of a working-class family. It should include adequate provision at least for the following items: (1) Food; (2) Rent; (3) Fuel and Light; (4) Clothing; and (5) Sundries. In estimating the allowance

* This amount appears to represent the joint earnings of a miner and his carrier, who is sometimes his wife.

modern world of commerce. One of the fundamental weaknesses of the system is inefficient labour, and this will continue unless immediate steps are taken to eliminate from that system such factors as are steadily undermining the physique of our working class.

One characteristic feature of the Indian worker is that he is still an immigrant from the countryside driven to seek employment in the industrial centres. The census figures from twelve cities and towns show that over 48 per cent of their inhabitants are born in rural districts. The transformation of a nation from an agri-industrial to a manufacturing community, as it has taken place in Great Britain, exercises a grave influence on the physique of the race. The process not only disturbs the balance between agricultural economy and handicrafts but fundamentally affects the health and nutrition of all communities. The population in the centres of urban life could not subsist without imported and processed foodstuffs; on the other hand rural areas could not retain for the growers themselves what was needed for a healthy subsistence.

Drawing upon the experience of the West, our task in India must be to maintain as far as possible the equilibrium between agriculture and industry, between urban and rural life. Economic necessity has brought India on to the road of industrialization, but she must guard against the risks of the disintegration which it eventually brings about in social, economic, and physical life. On account of certain socio-religious customs, the institution of factory feeding, as it is adopted in some of the Western countries, may not be a practical proposition in India. We should therefore explore other possibilities by which the workers' dietary requirements may be satisfied. While it should be obvious from our study of the family budgets that the wages of the workers are totally inadequate for even bare subsistence, we can imagine what must be the state of nutrition of those drawing wages far less than those of the first group in these budgets.

'All enquiries go to show', observes the delegation of the British Trade Union Congress to India in 1928, 'that the vast majority of workers in India do not receive more than about 1s. per day. In the province of Bengal, which includes the large mass of industrial workers, investigators declared that as far as

Another important measure for insuring adequate and, above all, wholesome nutrition to the Indian working class is the control and supervision of the food vendors and eating places in the industrial areas. As we have already shown, the inferior and even adulterated food sold in these eating places is one of the causes of the malnutrition of the workers. The laws against adulterated and injurious foodstuffs should be extended and perfected, and they should be rigorously enforced. A certain number of approved food vendors and restaurants should be licensed by the Government or the Local Authority, and their wares should be kept under constant supervision by a staff of expert inspectors. Unlicensed restaurants should be suppressed. In this way it would be possible to keep a real control over the wholesomeness of the foods usually sold to the working people.

The experience of Soviet Russia seems to show that the establishment of communal restaurants in factories and work places goes far toward ensuring a satisfactory diet to the people. Such a system, however, is probably not practicable under the present conditions of Indian industry, and might in any case prove unpopular with the work people on social and religious grounds. But there can be no doubt that the system has many advantages, and while not recommending it for universal application in the factories themselves, we would suggest that it might profitably be introduced in a modified form by the trade unions. Thus some of the larger trade unions could open modernized and scientifically run restaurants for their own members in the chief centres of industrial activity. Besides providing meals in accordance with the requirements of modern nutritional science, such restaurants could serve a most useful purpose in propagating and popularizing knowledge of nutrition among the working class. We have no doubt that, if the prices charged were such as the workers could afford, the venture would meet with great success and would spread rapidly. It would confer a real benefit on the nutrition of the working class.

Finally, an intensive campaign of education and propaganda in nutritional knowledge should be carried out in a systematic way, particularly among the women workers. The instruction given should be practical rather than theoretical, and should

necessary for food, the standard of dietary requirements issued by the League of Nations or some other reputable authority, should be used as a basis. It would then be necessary to translate this standard into the terms of a practical dietary, taking into consideration on the one hand the national, social, and religious customs of the people, and on the other, the most economical method of satisfying nutritional needs. The cost of such a dietary could then be calculated and added to the cost of the other necessaries to form the standard of the minimum wage. Naturally the cost of all these items would differ considerably in the different provinces of India; and for this reason it would probably be better for the provinces to establish their minimum wage scales independently.

In suggesting a system of minimum wages for England, Mr. Seebohm Rowntree in his book, *The Human Needs of Labour,** considers that the introduction of such a system should be gradual and spread over a period of years. For the sudden imposition upon industry of wage scales appreciably higher than formerly would merely have the effect of raising prices, thus negativing the benefits of the minimum wage. But Mr. Rowntree argues that if a minimum wage were set as a goal to be achieved gradually over a period of, say, five years, industry would be able so to adapt itself to the new conditions by effecting economies of organization, that it could support the added burden without transferring it to the consumer. This is especially true of India, where the productivity of labour is shockingly low compared with the advanced Western countries. A higher wage scale would involve, and indeed necessitate, a marked rise in the productivity of labour.

That a system of minimum wages is both practicable and efficacious is proved by the example of New South Wales where such a system has long been in force. We have discussed the experience of New South Wales in Chapter Seven; and a careful study of that experience—the standards on which the minimum wage is based, the methods devised for allowing the scale to rise and fall with variations in the prices, the actual effect of the system on industry and on the conditions of working-class life—would certainly provide much useful guidance in introducing the system into India.

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results of a survey of 'certain public health aspects of village life in India'. It showed that, taking India as a whole, only 39 per cent of the people might be regarded as being well nourished.

Below our peasantry, there is still another even more helpless working class whose diet is alarmingly inadequate and ill-balanced. One of the inevitable consequences of present-day agricultural economy in India is the growth of a landless proletariat and in a great part of India this vast population is reduced to conditions of life reminiscent of serfdom. In 1921 for every 1,000 cultivators there were only 291 farm labourers but within the following ten years the number increased to 407. The average wage in rural areas even in the comparatively prosperous province of the Punjab varies between 7d. to 1s. 2d. per day.

The morning meal of our agricultural labourer in the rice-growing regions is a portion of cooked rice set aside and allowed to soak in water overnight. It becomes slightly acidulous and is eaten with curds, chillies, or dhal. In the wheat or millet areas, the labourer's breakfast consists of stale chapati with *gur*, or a few morsels of soaked gram. The subsequent meals are mainly composed of cereals. The major part of the wages of an agricultural labourer is spent on grains, the amount of which is usually determined by custom and not by his needs or those of his family.

Of the plantation labour, the workers in the Assam tea-gardens may be taken as a representative group. They are largely recruited from Bihar, the United Provinces, Central Provinces, and Madras Presidency on a short-term contract. The policy of maintaining a constant influx of new labour forces is advantageous to the plantation owners because it keeps the scale of wages down. The average monthly wage for an adult male is Rs. 14 (21s.), adult female Rs. 10·8 (about 15s.), and children Rs. 7·4 (about 10s.). They are provided with huts and in some cases an allotment of land.

Although most of the workers come from wheat- or millet-growing areas, they [illegible] diet consists chiefly [illegible] quantity of vegetab[illegible] rarely used but fruits are available in certain seasons. Various

confine itself to what is possible in the way of diet in relation to the extremely low wages of the working class. But as we have had occasion to emphasize more than once in the course of this book, education and knowledge by themselves are not enough. The working class suffers from malnutrition not because it is ignorant but because it is poor; and it is established beyond doubt that without the provision of an adequate living wage, the greater part of the industrial and agricultural proletariat cannot have the primary requisites of healthy living. Doubtless ignorance makes worse a condition which would in any case be bad enough; but the root cause is poverty. There is every reason to believe that if working-class incomes were adequate, the nutrition of the working class, while it might not be ideal, would at least be adequate also. Thus education can only serve a really useful purpose when the income level has been raised at any rate to a minimum standard.

The Diet of the Peasantry and Plantation Labour

In a country where farming is largely on a subsistence basis, one might assume that the tiller of the soil does not suffer from undernourishment. But the truth is that, in most cases, both in quantity and quality, his diet is below the standard of normal requirements. 'It would be a mistake', observed McCay in summing up his investigations, 'to suppose that the average dietaries of the mass of the population outside the jails is on a par with the jail dietaries.' The diet E of the jail code in the United Provinces consists of about 23 oz. wheat, 5 oz. gram dhal, 6 oz. vegetables and condiments; as against the average daily consumption per adult outside the prison estimated at 16 oz. cereals, 4 oz. dhal, and 4 oz. vegetables and condiments.

Very little statistical information is available regarding the exact state of nutrition of our peasantry, and in view of the wide variations in conditions of life from one region to another it is difficult to convey an accurate idea on the basis of fragmentary data. Yet the inadequacy of nutrition among a large percentage of the population engaged in food production is a fact that at once strikes those who take the trouble to enquire into the economic aspects of rural India. About five years ago Sir John Megaw of the Indian Medical Service published the

DIET AND PHYSIQUE OF INDIAN RACES.



Hunza Hillman Diet whole cereal grains (mainly wheat), milk, vegetables and abundant fruits - apricots etc meat occasionally



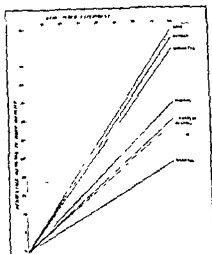
Average representatives showing weight in grams of 7 groups of rats fed from the same early age on certain national diets of India The best of these diets (Sikh) was composed of whole wheat, butter, milk legumes vegetables with meat occasionally The worst (Bengalis and Madrassis) is one composed mainly of rice



Tibetan Hillman: representative of dandy carriers rickshaw-men, etc. Very hard worked Average protein intake 175 grams daily of which over 60% is derived from animal sources *The heat value of their diet may be as much as 8 000 calories daily* (McCay).



East coast cultivator: Diet. rice with dhal and vegetables and a small amount of fish, milk, and butter Protein from 50 to 70 grams daily calories 2 400 to 2750 (McCay).



Percentage increase in body-weight of 7 groups of young rats of the same initial aggregate weight fed on certain national diets of India (vide photograph above)



Nepalese Hillman (Goorkha) Protein 120 to 130 grams, of which less than one third is derived from animal sources Calories 3,000 to 3,200 Such people eat largely of the better class cereals - wheat, maize and good millets (McCay).



Bengali Diet rice, dhal vegetables oil with a little fish and perhaps a little milk Protein, 50 grams daily Calories 2,300 to 2,500 (McCay)



Mahratta Sikh Pathan

(McCay)



Typical of rice-eating Madrassi. Diet contains little or no animal protein Calories low. (McCay)

IX Note fine physique of races (Mahratta, Sikh, Pathan) whose diets are well constituted, and poor physique of those (Bengali, Madrassi) whose diets are ill-constituted Note similar effect in rats fed on these diets From left to right

kinds of greens (sags) fried in mustard oil are popular. Qualitatively the diet is very deficient in fat, poor in all vitamins, and its protein is almost entirely obtained from vegetable sources. As regards quantity it is decidedly less than that provided in hospital or prison. Dr. Margaret Balfour's enquiry into the diets of a certain number of families shows that each adult receives about 15 ounces of food yielding approximately 1,460 calories. It is not surprising that anaemia and stomatitis are so common among tea labourers of both sexes in Assam.

Discussion of Indian Dietaries

Before summing up the chief defects of the dietaries described above, we should refer to a series of striking experiments conducted by McCarrison at Coonoor. He sought to determine for the first time the relative values of seven typical Indian dietaries by feeding groups of albino rats on foodstuffs resembling as far as possible those that are habitually consumed by the Sikh, Pathan, Mahratta, Gurkha, Kanarese, Bengalee, and Madrassi communities. Starting from the same age and weight, the rats at the end of two months and a half yielded the following results:

TABLE XVII

Experimental Data on Seven Typical Indian Dietaries

Diet	*Mean Body-weight*	*Body-weight gain in Percentage*
Sikh	235	60
Pathan	230	58
Mahratta	225	54
Gurkha	200	40
Kanarese	185	35
Bengalee	180	33
Madrassi	155	23

In the first place, most of these diets are strikingly deficient in proteins, especially those of animal origin. It is argued that the relatively low protein and high carbohydrate content of

most of the typical Indian dietaries may be regarded as a form of dietetic adjustment to physiological needs. The average food intake of almost all the communities, however, even if it supplies the calorie requirements, provides no margin to serve as 'reserve energy'. Among the bulk of the rice-eating population the supply of protein has reached almost its lowest limit. In the wheat-growing tracts, the average daily protein intake, though below the standards of minimum requirements, is relatively large. Indeed the problem of an adequate supply of 'good' proteins throughout India should be investigated in all its aspects if the nutritional status of the masses is to be correctly assessed and understood. According to McCay the capacity of absorbing proteins varied among the different racial groups that came under his observation in Bengal prisons. He found a somewhat close connection between the physique of different races and tribes and the levels* of protein metabolism attained by them, and showed how in consequence of the low rate of absorbability, a considerable part of the protein intake is wasted. A few instances cited by McCay in elucidating his thesis will be of interest. He observed that the absorption of proteins from cooked rice is actually diminished when excessive quantities are eaten. For example, 8½gm. were absorbed when 19 oz. of rice were eaten daily, but only 6½ gm. when 30 oz. were consumed. The larger ration does not make up for the poorness in proteins of the diet but rather the reverse, while the excess of carbohydrates upsets the balance of the diet.

Certain vegetable sources of protein are unsatisfactory. From a diet of millet, dhal, and vegetables containing 16 gm. of protein in all, only 9½ gm. were absorbed, whereas from a diet of wheat containing 16 gm. of protein as much as 13 gm. were absorbed. Thus, a diet containing *atta* indicated a better percentage of nitrogen than the usual Bengalee food.

Secondly, although our fat requirement is not as much as

* Nitrogen metabolized per kilo of bodyweight was estimated by McCay as follows:

	gram
Nepalese Bhutia	0·42
Tibetan	0·35
Sikkim Bhutia	0·25
Nepalese	0·18 to 0·25
Behari	0·14
Bengalee & Oriya	0·11

age and sex groups, which may be 'sufficiently accurate for practical nutrition work in India'.

TABLE XVIII

Scale of Average Calorie Requirements

Age Group	*Calories Required*
Adult male (over 14)	2,600
Adult female (over 14)	2,080
Child 12 and 13 years	2,080
Child 10 and 11 years	1,820
Child 8 and 9 years	1,560
Child 6 and 7 years	1,300
Child 4 and 5 years	1,040
Child 2 and 3 years	780
Child 0 and 2 years	520

If we take this figure of 2,600 as the basis of an adequate adult diet, the question is, how to plan a diet yielding this number of calories which is at the same time in other respects 'well-balanced' and which is yet within the means of the average Indian worker or peasant. In the diagram in Appendix VII Aykroyd shows first an ill-balanced diet which, he says, is 'typical of diets consumed by millions in India'. Below he shows how this diet could be improved by a decrease in the quantity of rice and its substitution by a substantially increased intake of milk, vegetables, greens, fruits and fats. 'The well-balanced diet', he says, 'contains protective foods in reasonable quantities, though actually it is far from being an optimum diet according to modern standards.' When, however, we enquire what is the difference in cost between these two diets the answer is discouraging. Aykroyd writes: 'At current retail prices in South India, the ill-balanced diet would cost about three rupees and eight annas (five shillings) per month per adult. The well-balanced diet would cost about five rupees (seven shillings and sixpence). Considered in relation to the level of wealth and wages in India, the difference is enormous. If a coolie has to support himself, his wife, his father, and three children on 16 rupees a month, the diet of the family will *inevitably* be ill-balanced, and probably insufficient in quantity as well. It will, in fact, be waste of time to attempt to persuade him of the advantages of the well-balanced diet, which is quite beyond his means.'

that of those living in temperate regions, our diets are generally poor in fats, most of which are of vegetable origin. The low proportion of animal fats (e.g. butter, ghee) in the diet is, as we have seen, one of the causative factors of deficiency diseases.

Thirdly, the diets are singularly poor in 'protective' foodstuffs. The supply of green vegetables is inadequate, and milk and fruits rarely enter into the dietary of the masses. It is estimated* that the *per capita* daily consumption of milk throughout India is not more than 7 ounces as against 35 ounces in the United States of America. 'Protective' foods are relatively expensive and their use is closely correlated with family incomes as is shown by the studies of family budgets in Great Britain and elsewhere. In recommending well-balanced but cheap diets to our undernourished people, one must not overlook the fact that a dietary expressed merely in terms of total calories may not supply adequate protective foods; calorific value is not by itself a safe criterion of a balanced diet.

Fourthly, carbohydrates form the main constituent in our monotonous diets. It is estimated that the average daily carbohydrate intake in India exceeds 480 grams per person. The low nutritive value of cereals usually consumed by the majority, excess of starchy foodstuffs, and inadequacy of vitamins and inorganic constituents are some of the disquieting features which render our cereal diets extremely liable to serious deficiencies. Sugar consumption in India is high because it provides a considerable part of the daily energy requirements; but this is an entirely devitaminized article of food and the increasing habit of using it, we repeat, should be discouraged.

We have already dealt with the question of dietary standards. That because of variable conditions of life, racial habits, physique, and climate in different parts of India, it is impossible to suggest a standard of energy requirements applicable throughout the country is obvious. However, in suggesting a standard of dietary, we should bear in mind that it must not only provide the bare nutritional requirements but must ensure a margin of safety and a degree of resistance to disease.

Taking into consideration all these factors, Aykroyd puts the minimum calorie requirements of an 'average' Indian at 2,600 calories per diem and suggests a scale applicable to the different

* See Appendix III.

CHAPTER SEVEN

Nutritional Research and Practice in Different Countries



The Responsibility of the State

In previous chapters an attempt has been made on the one hand to present in outline the history of the development of nutritional science, and on the other to show the precise effects of malnutrition and general undernourishment. From this discussion two facts should have become obvious. First, that the consequences of malnutrition are extremely serious and are sufficiently widespread to constitute a problem demanding serious action in all countries which consider themselves civilized. Secondly, that our present knowledge of the scientific principles of nutrition, though still in many respects imperfect, is sufficiently advanced to enable this problem to be met and overcome as soon as public opinion has been aroused to the point where governments are compelled to take it seriously in hand.

The duty and responsibility of the State with regard to malnutrition is not obscure. During the last hundred years the realization of the function of the State as organizer of what may in a wide sense be called the social services has been constantly increasing. Since the middle of the nineteenth century one sphere of social activity after another has been undertaken either in whole or in part by the State. Education, conditions in factories and mines, public health, came, in England and in most European countries, under the control of the Government before the end of the century. Old-age pensions, social insurance, the maintenance of the unemployed were added just

These observations of Aykroyd fully confirm the main thesis of this chapter, namely, that any substantial improvement in Indian dietaries is out of the question if the income of the working class and the peasantry remains at its present low level. Minor improvements might, perhaps, be effected by the substitution of, say, millet for a part of the rice, or by the use of unmilled rice. But the only real solution for the problem of malnutrition, which afflicts large sections of the Indian communities and debilitates the population, is an appreciable increase in the income of the workers and peasants. If poverty is the root cause of malnutrition, only the removal of poverty will provide a solution of the problem.

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The discussion naturally falls into the following sections: a description first of the organization, both international and national, of nutritional research and propaganda; then of the actual methods adopted in a few selected countries to deal with malnutrition among various special sections of the population —mothers and infants, children of school age, and certain classes of adults.

Organization of Nutritional Research

(a) *International*

In spite of the rapidly increasing interest in the problems of nutrition during the years since the War, there was a rather surprising slowness to co-ordinate the organization of nutritional research on an international scale. In 1925 the Assembly of the League of Nations requested the Health Organization to investigate certain problems connected with the manufacture of food products. This was the first sign of interest by the League in nutritional research. The following years saw a number of investigations of special problems in various countries organized by the Health Committee.

In 1928 the French Government asked the Health Committee definitely to place nutrition on its programme of work. It was not until four years later, however, that a serious beginning was made on the international organization of nutritional research. By 1932 the disastrous effects of the economic crisis on the physical condition of the working classes could no longer be ignored, and co-ordinated international action became imperative. In this year, accordingly, two Conferences of Experts were convened. The first met at Rome in September to consider the question of dietary standards and to draw up a scale of family coefficients for international use in order that the enquiries on the state of nutrition in various countries might be made comparable. The second, meeting at Berlin in December, considered the physical standards and the clinical and physiological methods best calculated to detect states of malnutrition.

In 1934 the Health Committee appointed Dr. E. Burnet and Dr. W. R. Aykroyd to draw up their now famous *Report on Nutrition and Public Health*[75] which, since its publication in

1935, has rapidly become one of the fundamental documents in the development of nutritional science. Almost all subsequent work on this aspect of nutrition has been explicitly or implicitly based on the conclusions arrived at in this Report.

During the Sixteenth Session of the Assembly of the League of Nations, in September 1935, delegates of twelve countries suggested to the President that 'the question of the relationship of nutrition to the health of the population which has become a social and economic problem of widely accepted significance, and is recognized as having an important bearing on world agricultural problems, should be placed on the agenda of the current session of the Assembly'.

The Burnet-Aykroyd Report was considered at length by the Assembly, and a three-day debate on nutrition, led by Mr. Stanley M. Bruce, the Australian delegate, and Lord De la Warr, took place in the Second Committee. The Assembly adopted the following resolution:

'The Assembly, having considered the subject of nutrition in relation to public health and of the effects of improved nutrition on the consumption of agricultural products, urges Governments to examine the practical means of securing better nutrition and requests the Council:

'(1) To invite the Health Organization of the League of Nations to continue and extend its work on nutrition in relation to public health;

'(2) To instruct the technical organizations of the League of Nations, in consultation with the International Labour Office and the International Institute of Agriculture, to collect, summarize, and publish information on the measures taken in all countries for securing improved nutrition; and

'(3) To appoint a Committee, including agricultural, economic, and health experts, instructed to submit a general report on the whole question, in its health and economic aspects, to the next Assembly, after taking into consideration, *inter alia*, the progress of the work carried out in accordance with paragraphs (1) and (2) above.'*

To give effect to the first paragraph of the Assembly resolution, the Health Committee appointed a Technical Commission. The Commission considered the question of dietary standards and published its findings in a Report on the *Physiological Bases of Nutrition*, a work to which we have often had occasion to refer in previous chapters of this book and which has superseded the work of the Rome Conference of Experts. This report forms Volume Two of the *Report on the Problem of Nutrition*, presented to the League in 1936 as a result of the resolution of the Assembly.

To give effect to the second paragraph of the same resolution, the Secretary-General, in November 1935, requested Governments to forward to the Secretariat, in the form of a general statement, any information which appeared to them to have a direct bearing on the improvement of nutrition. This material has been arranged and published as Volume Three of the *Report on the Problem of Nutrition* under the title *Nutrition in Various Countries*.[76] We have drawn greatly on this volume for the information contained in the present chapter.

To give effect to the third paragraph of the Assembly resolution, the Council set up the Mixed Committee on the Problem of Nutrition, which held two sessions in February and June 1936 under the chairmanship of Lord Astor. Members of the Technical Commission of the Health Organization, and representatives of the International Labour Office and of the International Institute of Agriculture sit on the Mixed Committee, whose title emphasizes the diversity of the interests bound up in the problem of nutrition. The Mixed Committee has published its findings in an *Interim Report* which forms the first volume of the *Problem of Nutrition*.[77] This volume discusses the question of nutrition in relation to public health and makes certain 'preliminary recommendations'. These recommendations are very varied, and urge upon the Assembly, *inter alia*, the necessity of encouraging nutritional research both nationally and internationally, and of co-ordinating the information acquired; of considering steps to relieve the nutritional needs

League of Nations has recently drawn attention to the desirability of forming similar committees in other parts of the world and to the close connection between nutrition and the question of rehabilitation of rural life.

of the poor, especially by the provision of milk in schools; of decreasing food prices while at the same time safeguarding the farmers; of improving the distribution and marketing of foodstuffs; and finally of considering the desirability of modifying the economic and commercial policies of certain states in order to assist the reorganization of agricultural production.

The International Institute of Agriculture has prepared a report on *Statistics of Food Production, Consumption, and Prices,*[78] which is published as Volume Four of the *Problem of Nutrition.*

In August 1937 the Mixed Committee issued its final report, a document of more than 300 pages, in which are summed up the conclusions of the four volumes of the interim report together with such additional research as has since been undertaken. The recommendations referred to above from the interim report are here reiterated and they constitute the testament of the League in regard to the problem of nutrition. This valuable report is divided into three parts. The first gives a general survey of the problem and indicates the role the science of nutrition has played in effecting improvement in public health. The second part is devoted to the influence of food on health and contains a résumé of the first volume of the interim report. The third part deals with the economic and agricultural aspects of the problem together with the evidence of malnutrition in a number of countries, which can be directly traced to the effects of poverty.

'Poverty and ignorance', states the report,[79] 'remain formidable obstacles to progress; the disparity between food prices and incomes increases the difficulty experienced by the poorer sections of the community in obtaining an adequate supply of the proper foods. In countries of the most diverse economic structure and general level of consumption appreciable sections of the population are, for one reason or another, failing to secure the food which is essential to their health and efficiency. Millions of people in all parts of the globe are either suffering from inadequate physical development or from disease due to malnutrition, or are living in a state of subnormal health which could be improved if they consumed more or different food. That this situation can exist in a world in which agricultural resources are so abundant and the arts of agriculture have been so improved that supply frequently tends to outstrip

effective demand remains an outstanding challenge to constructive statesmanship and international co-operation.'

To those countries where agriculture is in a backward state and the agricultural policy is not related to the problem of nutrition, the expert opinion of the Committee should be of special interest. It is argued that *planned* action towards better nutrition should have a far-reaching effect upon national agricultural systems, bringing about consequential changes in the health and well-being of a vast population.

We now turn to another publication of international importance which laid special stress on the state of nutrition of workers. While the health organization of the League had been engaged in collecting data for the Reports mentioned above, the International Labour Office had not been idle. At its Conference in June 1935 it had discussed the question of nutrition and had resolved to continue its investigations of the problem, particularly in its social aspect, working in collaboration with the organizations of the League, with a view to presenting a report on the subject to the 1936 session of the Conference. Accordingly a long Report[80] was submitted under the title *Workers' Nutrition and Social Policy*. The Report brings together a very large amount of important material on the living conditions of the working class throughout Europe in relation to nutrition. It finds that undernourishment and malnutrition are widespread and are not the result merely of the economic crisis but are present also in times of normal business activity. 'Low income or lack of purchasing power', the Report states, 'is thus the root cause of the inadequate nutrition of large numbers of workers and their families.' The Report as a whole is of the greatest interest because it confirms on a wider scale, although on a less precise basis, many of the general conclusions of Sir John Orr's Report, of which we have already given an account.

This then in brief outline is the history of the investigations of the problem of nutrition which have been undertaken on an international scale. The Burnet-Aykroyd Report, the four volumes of the report on the *Problem of Nutrition* and the report of the International Labour Office are excellent examples of what international co-operation and co-ordination can achieve in the space of a few years. Together they contain an extra-

ordinary wealth of material and they must remain for many years to come the starting-point of all further work on the subject.

But while these investigations had been proceeding internationally, many of the nations had been going into the problem on their own account. Some of them had conducted elaborate and valuable research on the subject from the national point of view, and had set up organizations to deal with the most pressing effects of malnutrition. To these national efforts we must now turn.

(b) Great Britain

Since the War, interest in and research on the problems of nutrition have been constantly increasing in England. The Government department responsible for this work is the Ministry of Health, which, since its foundation in 1919, has always insisted on 'the vital importance of nutrition as a fundamental factor in personal and public health'. The Ministry's activities with regard to this subject fall into two categories: supervision of the administration by local authorities of the legislation designed to safeguard the purity and wholesomeness of the food supply; and educational and propaganda work with a view to disseminating knowledge of food values and the needs of the human body. The Minister of Health is responsible for bringing before Parliament such legislation as may be necessary. He also has parliamentary responsibility for the work done by the local authorities with regard to nutrition in schools, although this work is actually organized and supervised by the Board of Education.

Besides its annual reports, which contain both scientific and popular information on nutrition, the Ministry publishes special reports from time to time the object of which is to supply useful information to health officers, physicians, teachers, and others who have opportunities for spreading scientific knowledge among the people. Finally, in conjunction with other scientific organizations and with local authorities, the Ministry carries out both theoretical research and practical investigations of various aspects of the problems of nutrition. Thus, for example, in 1921 the Ministry in conjunction with the Medical Research Council made arrangements for exhaus-

tive investigations by Dr. Corry Mann, extending over four years, into the nutritive value of milk as compared with other foodstuffs. In conjunction with local authorities, moreover, the Ministry has carried out from time to time extensive investigations of family dietaries both from a quantitative and qualitative point of view, the object of which is to ascertain the nature of the diets consumed by people in different parts of the country.

The Medical Research Council gives extensive financial support, from funds provided by the Government, to work on nutritional research. With its aid research has been carried out on such subjects as the function of the various dietary constituents in maintaining health, the pathology of deficiency diseases, the nature and distribution of the vitamins and their standardization, the analysis of common foodstuffs, and many other related problems.

Another important organization for research in this field is the Advisory Committee on Nutrition which was appointed in 1931 'to advise the Minister of Health on the practical application of modern advances in the knowledge of nutrition'. In 1935 it was reconstituted and enlarged for the purpose of enquiring 'into the facts, quantitative and qualitative, in relation to the diet of the people', and of reporting 'as to any changes therein which appear desirable in the light of modern advances in the knowledge of nutrition'. The Committee is composed of distinguished scientific authorities, physiologists, statisticians, and economists.

Under the Milk Act 1934, there was set up a Milk Nutrition Committee which is now conducting an extensive investigation into the effect of feeding milk to schoolchildren. A total of about 8,000 children in various areas is divided into four groups; a control group; a second group which receives one-third of a pint of pasteurized milk once daily; a third group which receives one-third of a pint of pasteurized milk twice daily; and a fourth group which receives one-third of a pint of raw milk twice daily. The children are medically examined before the supplementary feeding and at intervals of three months over a period of at least a year. When this experiment is completed we shall be in possession of precise information as to the effects not only of the *amount* of milk but also of the *type*

of milk—pasteurized or raw—on the health and growth of children.

We have already had occasion to mention in this chapter the extensive investigations summarized in Sir John Orr's report on *Food, Health, and Income*. This research was done under the auspices of the Market Supply Commission in conjunction with the Rowett Research Institute, and is an example of the admirable work on nutrition which is being undertaken by organizations which are not directly concerned with dietary problems. As we saw above the result of this enquiry was to demonstrate that the problem of malnutrition in England was far more serious and widespread than had formerly been supposed.

In addition to these official or semi-official institutions directly financed by the State, there are in England a number of organizations run wholly or partly by private initiative which study various aspects of the problem of nutrition. Much work on this subject is done, for example, in the universities, especially at Cambridge where there is an important department for the study of nutrition. Perhaps the most famous organization of this kind is the Rowett Research Institute attached to the University of Aberdeen to which we have already referred. Although primarily an institute for research into animal nutrition—the Institute possesses extensive experimental farms—important surveys and investigations of human nutrition are also carried out under its direction, as the pioneer enquiry of Sir John Orr testifies. For example, a large-scale survey of the dietaries of certain sections of the population of Scotland was undertaken to determine the extent to which various minerals—iron, phosphorus, and lime—were lacking in the usual diets, and what were the effects of this deficiency. Again, the famous investigation of the diets of the two African tribes, the Kikuyu and the Masai, to which we have referred in Chapter Two, was undertaken under the direction of the Rowett Institute. In addition to investigations of this kind, the Institute edits a quarterly journal, *The Nutrition Abstracts and Reviews*, which contains summaries of all important articles on the different aspects of nutrition that appear in the scientific and medical journals of the world.

It seems doubtful whether any other Western country has

undertaken the task of nutritional research so extensively as Great Britain. We have therefore selected Japan, the most highly developed country of the East, as affording another example of efficient and well-planned research on nutrition.

(c) *Japan*

Japan has the distinction of possessing one of the oldest organized institutions for nutritional research in the world. As far back as 1902 the Ministry for Home Affairs established the Research Institute of Nutrition. It was a small organization, consisting of only six experts and nine technical assistants, and its work has been overshadowed by the later and more extensive organization for nutritional research.

The Imperial State Institute for the Study of Nutrition was founded at the end of 1920. The threefold aim of its investigations is thus summarized by Dr. Saiki, its director: '(1) To determine what natural products can satisfy food requirements, and then select those the consumption of which would be most advantageous from a purely physiological point of view; (2) to select from the latter group the substances which best meet the requirements of national economy; and (3) proceed, in this last group, by selection based on social considerations, to draw up a "food code" which, though it may not be perfect, will, under existing social conditions, be the nearest approach to perfection we can attain.'

The large and highly skilled staff of experts of the Institute is conducting detailed research into a variety of problems. An important series of investigations have been made on the physiological bases of nutrition with special reference to Japanese men and women. Interesting studies have been carried out on basal metabolism, not merely of normal or average people, but also of people in different specified professions and trades, especially labourers of various sorts. Methods of measuring energy exchange and body surface area have been improved and applied to the Japanese.

Among the studies of individual foodstuffs, those on rice are of particular importance. In order to determine the digestibility and biological utilization of rice of different grades of polishing and cooked by different methods, an elaborate and

well-controlled series of experiments was carried out not on animals but on people. The general conclusion of these experiments is that: 'The digestibility and utilization of rice are always better when the grades of polishing are higher. The ration of actual energy derived from the rice to the total energy value of the rice eaten varies directly with the digestibility.' Moreover, the satiety value of unpolished rice appears to be high, with the result that there is a tendency to consume less of other foodstuffs when the staple article of diet is unpolished rice. Thus the caloric value of such a diet is definitely insufficient for the requirements of the body. This conclusion is disturbing in view of the fact, which we have several times had occasion to emphasize, that polished rice contains no vitamin B_1 while unpolished rice is rich in this substance. If the researches of the Japanese Institute on this subject are borne out by further investigation, the problem of overcoming beri-beri among populations whose staple diet is rice cannot be so easily solved as by the simple substitution of unpolished for polished rice. It would seem necessary to introduce into the diet some other substance, say unmilled wheat, which is rich in vitamin B.

The Institute has undertaken some interesting and highly important experiments on vitamins, especially vitamin A. As we have shown in the course of our discussion on the effects of vitamin deficiency, the best known and most pronounced result of lack of vitamin A is keratomalacia. Dr. Fujimaki of the Japanese Institute, however, seems to have established a relation between vitamin A deficiency and urinary and bile-duct calculi (stones) and also gastric carcinoma (tumours or cancer of the stomach). If further work along these lines supports the conclusions of Dr. Fujimaki, it is clear that a very important advance will have been made both in our knowledge of the aetiology of these diseases and in their treatment.

From these few examples it will be seen what admirable work is being carried out by the Japanese Institute of Nutrition. With the possible exception of the similar Institute in Soviet Russia, the Japanese Institute appears to be the most extensive and the best organized and equipped which exists.

So far we have drawn examples of nutritional research and organization from two countries, one in the western and the other in the eastern hemisphere, where the political and

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well-controlled series of experiments was carried out not on animals but on people. The general conclusion of these experiments is that: 'The digestibility and utilization of rice are always better when the grades of polishing are higher. The ration of actual energy derived from the rice to the total energy value of the rice eaten varies directly with the digestibility.' Moreover, the satiety value of unpolished rice appears to be high, with the result that there is a tendency to consume less of other foodstuffs when the staple article of diet is unpolished rice. Thus the caloric value of such a diet is definitely insufficient for the requirements of the body. This conclusion is disturbing in view of the fact, which we have several times had occasion to emphasize, that polished rice contains no vitamin B1 while unpolished rice is rich in this substance. If the researches of the Japanese Institute on this subject are borne out by further investigation, the problem of overcoming beri-beri among populations whose staple diet is rice cannot be so easily solved as by the simple substitution of unpolished for polished rice. It would seem necessary to introduce into the diet some other substance, say unmilled wheat, which is rich in vitamin B.

The Institute has undertaken some interesting and highly important experiments on vitamins, especially vitamin A. As we have shown in the course of our discussion on the effects of vitamin deficiency, the best known and most pronounced result of lack of vitamin A is keratomalacia. Dr. Fujimaki of the Japanese Institute, however, seems to have established a relation between vitamin A deficiency and urinary and bile-duct calculi (stones) and also gastric carcinoma (tumours or cancer of the stomach). If further work along these lines supports the conclusions of Dr. Fujimaki, it is clear that a very important advance will have been made both in our knowledge of the aetiology of these diseases and in their treatment.

From these few examples it will be seen what admirable work is being carried out by the Japanese Institute of Nutrition. With the possible exception of the similar Institute in Soviet Russia, the Japanese Institute appears to be the most extensive and the best organized and equipped which exists.

So far we have drawn examples of nutritional research and organization from two countries, one in the western and the other in the eastern hemisphere, where the political and

undertaken the task of nutritional research so extensively as Great Britain. We have therefore selected Japan, the most highly developed country of the East, as affording another example of efficient and well-planned research on nutrition.

(c) *Japan*

Japan has the distinction of possessing one of the oldest organized institutions for nutritional research in the world. As far back as 1902 the Ministry for Home Affairs established the Research Institute of Nutrition. It was a small organization, consisting of only six experts and nine technical assistants, and its work has been overshadowed by the later and more extensive organization for nutritional research.

The Imperial State Institute for the Study of Nutrition was founded at the end of 1920. The threefold aim of its investigations is thus summarized by Dr. Saiki, its director: '(1) To determine what natural products can satisfy food requirements, and then select those the consumption of which would be most advantageous from a purely physiological point of view; (2) to select from the latter group the substances which best meet the requirements of national economy; and (3) proceed, in this last group, by selection based on social considerations, to draw up a "food code" which, though it may not be perfect, will, under existing social conditions, be the nearest approach to perfection we can attain.'

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economic structure is based on the capitalist system. Here the doctrine of *laisser faire* modified under the exigencies of circumstances, governs the general order of the state and society. It will now be interesting to consider some of the activities of similar institutes of research functioning under circumstances altogether different in the Soviet Union. Here we find a new form of State and a sphere of economics where *laisser faire* is totally replaced by planned economy; and here the demand for social reconstruction comes not from a governing class but from the voice of organized labour.

(*d*) *The Soviet Union*

In nutrition as in so many other fields the U.S.S.R. provides a number of important and instructive examples. The Soviet Union, unlike all other countries, considers food supply a public service. 'The state does not merely inspect foodstuffs from a health point of view and punish fraud (as in all other civilized countries); in conformity with the doctrine of the Communist Party, it aims at organizing the nutrition of the people in accordance with the laws of physiology and the norms of hygiene. The nutrition of each individual should be determined, not by his income, but by his needs.'

Nutritional research is carried out by the National Institute of Nutrition, which has its head office at Moscow. Subsidiary institutes have been established in Leningrad, Kharkov, Kiev, Rostov, Novosibirsk, and Tiflis. The Institute of Nutrition is not an administrative organ, but an institution for scientific research and a technical adviser to the Government. Unlike many other States, however, the Soviet Government appears to be most willing to accept and put into practice the advice tendered by the scientific authorities of the Institute.

The Institute is divided into six sections. The physiological and bio-chemical section lays down norms or standards. The food hygiene section investigates problems connected with the sanitary conditions of food preparation and, in particular, with the technique of cooking and serving food. The work of the department concerned with the development of the technique of treating food materials is of particular importance in connection with collective or social feeding, which will be discussed below. The department of dietetics and therapeutic

nutrition investigates the function of nutrition as a branch both of preventive and of curative medicine. Another department is engaged in the general education and training of a technical staff. A fifth section deals with the nutrition of mothers and infants. Finally, there is an economy section which issues plans and statistics.

The institute is engaged on a varied and extensive programme of research. Of particular interest is its work on vitamins and the preparation of vitamin concentrates. The most acute of the deficiency problems of the U.S.S.R. is scurvy, produced as we have seen by lack of vitamin C. Scurvy is particularly common in the northern regions of Russia and Siberia. With the increasing concentration of population in these regions, the problem of overcoming the lack of vitamin C bearing foods has become pressing. The Institute of Nutrition has for some time been experimenting with various preparations of vitamin C in a concentrated form. For centuries the hunters of the arctic and sub-arctic regions have known that an infusion of pine needles would prevent scurvy. Such an infusion, however, is excessively bitter and must be taken in large quantities. The research workers of the Institute discovered a method of preparing a highly concentrated extract of vitamin C from pine needles, which could be inserted in small quantities into chocolate-creams and other sweet substances without imparting a disagreeable taste. Extracts of this vitamin have also been prepared from reeds, turnips, black currants, cedar needles, rose hips, and several other things; rose hips, as it appears, being the richest source of vitamin C. As a result of these discoveries by the Institute, factories have already been established to manufacture this extract, 10,000 man-doses being turned out daily by a small factory in Leningrad. Much larger factories are in process of erection. It is believed that by the extensive use of this extract, scurvy may be stamped out even in those regions which cannot produce sufficient quantities of fresh vegetables containing vitamin C.

Another branch of research undertaken by the Institute is the investigation of the varying food requirements of workers in different occupations. The general dietary standards—for proteins, carbohydrates, fats, etc.—set up by the Institute are, as we have already noted, considerably higher than those

recommended by nutritional experts in the West. 'The standards adopted', say Burnet and Aykroyd, 'are about 15 per cent higher than the standards allowed in western Europe or in the United States of America.' And this is confirmed by Clark and Brinton.[81] These standards, however, both those proposed by Western and by Soviet authorities, are in their very nature only approximate, since they take no account of differences of occupation, climate, and so forth. The trend of nutritional research in the U.S.S.R. is away from such rough averages in which important individual differences are submerged, and toward a precise investigation of the variations in dietary requirements, first among different occupational and climatic groups, and finally even in individual cases. Extensive research has been undertaken in both these fields, for a parallel to which one looks in vain in any other country. 'The occupations examined', according to Clark and Brinton, 'include those of carpenters, brick-carriers, masons, plasterers, engine-drivers, stokers, guards, carriage-couplers, loaders, sorters, mechanics, blacksmiths, workers in rolling shops and foundries, tractor-workers, machine-threshers. This is only a part. In agriculture such processes as horse-ploughing, scythe-mowing, machine-mowing, sheaf-binding, work on root crops, have all been investigated. We append a table showing some of the estimates of average daily energy expenditure in calories for a normal day's labour (now at most seven hours in all industries):

Engine-drivers	2,900–3,100
Heavy work in chemical plants	3,800–4,100
Plasterers	3,900
Foundry workers	4,000–4,500
Brick-carriers	5,400
Scythe-mowers	7,200

The very great variations displayed in this table—from 2,900 to 7,200—are of the greatest interest when compared with the rough average standards of calorie intake proposed both by Western and by Soviet authorities: we have seen that the standard generally accepted in the West is about 3,000 while that proposed by the Soviet Institute is 3,644.

One further aspect of Soviet nutritional research must be noted, namely the attention given to nutrition as a branch of

curative and preventive medicine. Naturally, with the discovery of the real aetiology of the various deficiency diseases, and with the increasing realization that incorrect or inadequate diet plays a large part in the predisposition to other diseases not specifically due to any definite deficiency, the importance of diet either as a cure or as a preventive has been widely appreciated. But in no country has so much practical work been carried out on this subject as in the U.S.S.R. Professor Pevsner is the pioneer and inspirer of this work. Already in 1922 the reports of his investigations began to be published. Gradually his theories became widely accepted, and in 1930 a Clinic of Therapeutic Dietetics was established at Moscow, well equipped with a laboratory and 100 beds for patients. Other such clinics have been established in some of the chief cities of the Union. Of course the hospitals and rest homes have all accepted the general principle of specific diets. Among the diseases studied in relation to diet Clark and Brinton mention tuberculosis, various forms of rheumatism and kidney complaint, heart disease, colitis, gastritis, gastric ulcers. Nutritional therapeutics is not at all confined, moreover, to clinics and special hospitals. Professor Pevsner was chiefly interested in seeing how far the appearance of these diseases in an acute form could be prevented by a timely dietetic treatment. This was rendered easier by the custom of collective feeding which we shall discuss at some length below. Here we need only say that in a large number of factory and other restaurants a variety of special diets is served. Clark and Brinton mention plants which serve as many as eleven different diets, and five or six appears to be quite common. The number of workers receiving these special meals is estimated by Burnet and Aykroyd at about 600,000, by Clark and Brinton at 590,000. From an analysis of health statistics in factories Clark and Brinton conclude that this work has achieved considerable results, though it appears to be too early to estimate precisely the extent of its importance.

Nothing testifies more clearly to the newness of the science of nutrition than the extremely rudimentary organization of nutritional research supported and directed by the State, whether in Europe or America. With the exception of England,

Japan, and the Soviet Union, there is scarcely a country where the State has established any adequate institution for research into the problems of nutrition. That the need for such an institution is widely felt, however, is made clear in Volume Three of the Report on *The Problems of Nutrition* in which country after country, admitting the present lack of proper research organizations, gives detailed plans of what it intends to do in this direction in the future.

Several governments have of late years appointed Committees for Nutritional Research which are generally connected either with the Ministry of Health, the Ministry of Agriculture, or the Ministry of the Interior, and sometimes with all three. But such committees are still too rudimentary and too recent for the importance and usefulness of their work to be properly judged. That they are being appointed, however, is clearly a good thing, and it is to be expected that if they are given adequate financial support and are free from interference they will do much toward elucidating the nutritional problems which confront the various countries.

Nutrition of Mothers and Infants

As we have shown in previous chapters of this book, the period of life during which adequate and scientific nutrition is particularly vital is the period immediately preceding and immediately after birth. It is at this time that the individual is being formed. Defective diet at this early stage will almost certainly leave lasting effects which any amount of corrective feeding at a later date will be powerless to overcome completely. Perhaps the commonest effect of inadequate diet at this early period is rickets, the cause of which, as we have seen, is lack of vitamin D; and an early deficiency of this vitamin is also largely responsible for defective and carious teeth. Both rickets and dental caries can of course be checked and to some extent corrected by adequate nutrition later on; but no amount of care after the fact can overcome the irremediable effects of these diseases.

Not only does defective diet in infancy lead to deficiency diseases the effect of which endures throughout life, but also to diseases which may prove immediately fatal or, if not so severe

as this, may at least weaken and undermine the infant's constitution. Such diseases are of two sorts. They may be deficiency diseases proper, as for example scurvy, which is common among the children of the poor in many parts of Europe and America, or infantile beri-beri which ravages large areas in the East, slaughtering the infant population, and is thought by some authorities to be not unknown also in certain Western countries. On the other hand, these diseases may not be deficiency diseases properly so called but diseases fostered by the lack of stamina and the lowered power of resistance, to which malnutrition leads. We have already shown that tuberculosis is the most common as well as the deadliest of those diseases which are indirectly caused or encouraged by deficiency in diet.

During this early period of an infant's life it is at first wholly and then in large part dependent for its nourishment upon its mother. Hence the supreme importance for pregnant and nursing mothers of an adequate and scientific diet. And this is no less essential for the mother herself, for only in this way can the tremendous strain of pregnancy be successfully borne. Deficiencies in the diet during this period lead to no less injurious and fatal results in the case of the mother than in that of the child. Various forms of anaemia, for example, are common among pregnant women whose diet is deficient in iron. Again, it is during pregnancy that the danger of osteomalacia is especially acute; while, as is well known, pregnancy has a particularly deleterious effect upon the general health which can only be overcome by an adequate and correct diet.

The principle of the proper nutrition of mothers and infants, then, has been clearly established and emphasized by the science of nutrition. Its practical importance is now universally realized. During the last ten years or so the governments of most of the European and American countries have officially recognized the obligation of the State to ensure an adequate protective diet to those mothers and children who, through poverty, are in danger of suffering from malnutrition. The steps taken by the various countries to give effect to this are many and differ from country to country. We will give some typical examples chosen from the chief countries of Europe and America which illustrate the kind of method adopted.

In *Great Britain* the importance of nutrition for mothers and infants was first officially recognized in the 'Maternity and Child Welfare Act' of 1918. This Act gave power to the county and borough councils and the urban and rural district councils to provide extra nourishment to expectant and nursing mothers and to children under five years of age. In 1930 this power was greatly extended and the local authorities were permitted, with the sanction of the Minister of Health, to increase this form of provision at their own discretion.

By the end of 1934 there were 422 maternity and child welfare authorities in England and Wales, the vast majority of which were supplying milk and often other foodstuffs to expectant and nursing mothers and to infants. In most cases also there are health visitors and instructors who give advice on the feeding of infants; and at the maternity and child welfare clinics instruction in problems of diet is given both individually and collectively.

Since 1929 there has been a great expansion of attendances at the maternity and child welfare clinics. Thus in 1934 the attendances of children under five was over eight million; this was an increase of nearly one million over the attendances in 1931. At the same time the attendances of women at the antenatal clinics increased from about two hundred thousand in 1931, to two hundred and fifty thousand in 1934. Toward the end of 1934 the local authorities were again urged to supply milk, either free or at less than cost price, in all cases where it seemed to be necessary or advisable.

In *France* the responsibility of the State to guarantee adequate nutrition to its citizens is only just beginning to be recognized, and methods of carrying out this obligation are still, to a large extent, in the state of being planned rather than actually put in practice. In certain districts of the country, however, milk dispensaries organized on a voluntary charity basis have been established to provide milk to expectant and nursing mothers and to infants. Even this is not, except in special cases, given free, but merely at prices somewhat lower than the commercial price. Instruction in nutrition is, however, provided.

The recent institution of social insurance by the State has had the effect of curtailing these voluntary milk dispensaries, because the industrialists who finance them plead, charac-

teristically enough, that since they contribute, at least ostensibly, to the social insurance, they cannot 'afford' to contribute to other undertakings.

In the *United States* the problem of ensuring adequate nutrition to mothers and infants is dealt with by the Federal Children's Bureau which works in the individual States through the child hygiene divisions and infant welfare agencies. These together with certain other public or private relief agencies, distribute milk and other foodstuffs to children and nursing mothers. It is to be expected that these services will be very much expanded under the new Social Security Act, which provides for a considerable increase in Federal aid to State and local public health agencies, and for the improvement and strengthening of the Federal public health service itself.

In the *Soviet Union* the practice of social nutrition has not yet fully caught up with and fulfilled the theory. The theory, however, is both remarkable and excellent, and for this reason the experience of the Soviet Union should be carefully studied, since on examination it appears that it has set many examples that might with advantage be followed by more advanced countries.

In accordance with the communist principle that the nutrition of the individual should be governed not by his income but by his needs, the diet and general welfare of mothers and infants has been made a special care of the State. Throughout the country, food centres or milk kitchens have been established where suitable milk and other essential foods can be obtained. Especially important is the attention paid to protective foods. Not only are fish oils of various sorts provided, but also preserved fruit juices, particularly necessary in the northern regions of Russia where fresh fruit and vegetables are often hard to obtain in winter, preparations of irradiated yeast, and similar vitamin extracts or concentrates. The centres provide the milk and foodstuffs either at a reduced price or free of charge. Thus, according to Clark and Brinton, in Leningrad in 1935, 15 per cent of the children were receiving their food free. In addition to supplying suitably prepared food at reduced prices or free, the centres provide expert advice on the nutritional needs of the infants and mothers after careful consultation and examination.

The truly remarkable thing about the Soviet organization of infant and maternal nutrition, however, is not so much what the centres actually provide—for this, as we have seen, can be paralleled in other countries, although it is doubtful if any other country lays so much stress on protective foods—as the vast, and indeed almost universal, extent of the system. In the towns of the U.S.S.R. at any rate 98 per cent of the infants are regularly seen at the centres, and the remaining 2 per cent probably represent merely change of residence. No other country can show a figure anywhere approaching this. It is clear that when the general level of production of the Soviet Union reaches that of the advanced Western countries, it will possess a social service in this respect unrivalled and as near to perfection as can well be attained.

Nutrition of Children of School Age

The adequate nutrition of children of school age is scarcely less important than that of infants and pregnant mothers. As might be expected, the necessity of ensuring a correct and sufficient diet to schoolchildren has been more widely recognized and at an earlier period. This is natural enough, since children who are at school come, in most of the advanced countries, under the constant supervision of the government authorities; their general state of health and development can be frequently observed. Any defect or illness arising from malnutrition is easy to discover, is indeed impossible to overlook. Governmental authorities, who in general ignore the existence of what is not forced on their attention, cannot in this case so easily shirk their responsibilities.

The results of malnutrition among children of school age are in many cases the same as among infants. Thus rickets may develop not only in infancy but also in early childhood; the same, naturally, is true of dental caries. The medical authorities of Great Britain reported in 1932 that 88 per cent of schoolchildren showed bone deformities (e.g. spinal curvature) and that over two and a quarter million pupils needed dental treatment. In general, moreover, children in schools are more exposed to contagious diseases than are infants. A state of imperfect nutrition weakens resistance to these diseases and

encourages their rapid spread. Also, when the constitution is debilitated by lack of proper nourishment, it is more severely attacked and more easily succumbs.

Another and more general result of the imperfect nutrition of children is the stunting of their growth and development. An individual's maximum height, for example, is determined by heredity, but whether or not he attains this height depends almost entirely on whether he has an adequate and correct diet. Not merely is a child's height, however, adversely affected by malnutrition, but also its development as a whole, both physical and mental. Aykroyd,[82] partly quoting from a report on the results of giving extra milk to schoolchildren, picturesquely compares the appearance and behaviour of well-nourished children with those of children who are suffering from lack of the proper diet: 'In practically every case, they (the children who were being fed extra milk) showed that sleekness peculiar to a well-fed animal; their hair was glossy and bright, their nails smooth, resilient and polished. General alertness was common to all, and they were also more difficult to control. Their *joie de vivre* runs away with them. Under-nourished children are apathetic, do what they are told, and are generally all that an adult can desire of children!'

To prevent these undesirable results of malnutrition among schoolchildren, many countries have developed an elaborate and well-planned system of school feeding by which those children who need it are provided with extra nourishment during school hours, either free of charge or at a very moderate price. We shall discuss two such systems—those obtaining in England and in France—to illustrate the various ways in which the problem may be dealt with, and the types of organization which experience has shown to be useful.

The extent and danger of malnutrition among children of school age first began to be realized in *Great Britain* after the passing of the Education Act 1870, which made school attendance compulsory. Thirty-six years were to elapse before any official action was taken to deal with the widespread malnutrition and sheer under-nourishment which were found to exist among the children attending school. But during this period a good deal of experimental and preparatory work was being done by voluntary organizations to provide extra food, and

sometimes whole meals, for those children who were most obviously suffering from inadequate nourishment. The experience of the Boer War brought the problem of malnutrition sharply to the foreground of public attention. It was found during the recruiting for that war that three out of every five men were physically unfit and had to be rejected. As a result of this unexpected situation various public enquiries were carried out to ascertain the cause of the widespread physical unfitness of the population. The most important of these enquiries was that of the Interdepartmental Committee on Physical Deterioration. The unanimous conclusion of all the enquiries was that the deterioration of the population was mainly due to malnutrition in childhood.

The result was the Education (Provision of Meals) Act of 1906. The Act provided that all undernourished children were to be supplied with a school meal, sold at cost price, to those who could afford to pay, and given free to those who could not. The immediate effect of this Act was an enormous increase in the number of meals served. From the 2¾ million in 1907–8, the figure jumped to 29½ million in 1914–15. During the War the number of meals served fell off considerably; but since 1918 there has again been a great increase. Thus in 1929–30 the figure was nearly 33 million and since that date it has steadily risen to its present size of over 68 million. The figures of the number of children fed are also interesting: from 156 thousand in 1913–14 they rose, with certain fluctuations, to 265 thousand in 1929–30 and 406 thousand in 1934–5.

The method of selecting the children to be given school meals varies considerably in different parts of the country. Sometimes the selection is solely by the application of an income test, sometimes it is made by the educational authorities' medical officers more or less regardless of income. The Board of Education has emphasized the view that 'selection by reference to an income test alone is not justifiable, and that regard should be had to the special circumstances of the child. The need of a child for feeding should not be considered only upon an application from the parent; the authorities should themselves take steps to ascertain what children are in need of feeding, by inviting reports from . . . those in regular contact with the children from day to day.'

There is also a certain variation in the type of meal served. The general practice is to provide a midday dinner; but some authorities serve breakfasts, dinners, and teas. The meals are in general supervised by the medical officers or other qualified persons, with a view to nutritional requirements. For the most part they are served in the school buildings or in adjacent canteens, though the experiment has been tried of contracting for the meals with a nearby restaurant, and even of sending the food to the homes of the children.

The cost of the meals was in 1935 approximately £557,000—and about 406,000 children were receiving them. When it is considered that there are in England and Wales nearly 8,000,000 children of school age, and that therefore little more than 5 per cent of them are receiving meals; and when further we remember that, according to Sir John Orr, about 50 per cent of the population as a whole suffers in some degree from malnutrition, it would seem doubtful whether the State were in fact discharging the duty laid upon it in the Education (Provision of Meals) Act of 1906, to provide that 'no child should be deprived of the full value of his education because of lack of food'. In short, although the system of school feeding in England is probably better and wider in scope than that obtaining in any other capitalist country, it is obvious that only the merest fringe of the problem has as yet been touched, and that what is being done is totally inadequate to meet the need that has been shown to exist.

During recent years the importance of milk as a protective food has been increasingly realized and insisted upon by doctors and dietary experts. When, therefore, the Government in 1934 yielded to the vested agricultural interests and set up the Milk Marketing Board, a useful and attractive way of keeping up the price of milk to the general public and yet disposing of some of the farmers' 'surplus', was found in the Milk-in-Schools Scheme. The Government placed £500,000 at the disposal of the Milk Marketing Board which in turn was to supply milk to schoolchildren at a halfpenny instead of a penny for one-third of a pint. The response to this arrangement—which was of obvious benefit to every one, for the Government pleased the farmers, the farmers got their profits, the public paid more for their milk and the parents of the recipients of the halfpenny

milk did not realize that they were paying the extra halfpenny in increased taxation (on tea and beer!)—was immediate. By the end of 1935 nearly 3,000,000 school children were receiving extra milk in school at the reduced rate; or, in the case of some quarter of a million children, free of charge. There can be no doubt of the extremely beneficial effect of this increased consumption of milk, and it is to be hoped that it is not beyond the ingenuity of man to devise some more rational method for extending the scheme.

In *France* the system of school feeding is not a function of the State but of the municipalities. For this reason there is inevitably a certain lack of uniformity in the methods adopted; but in spite of this, there are some characteristics of the French experience which are worth noticing.

School feeding in France originated (rather earlier than in England) on a voluntary basis. Volunteer *caisses des écoles* or school fund committees were founded in many of the towns and cities. Among many other activities, these committees undertook to provide meals for indigent school children. From the first, the local municipal councils frequently made grants to the *caisses*, and as time went on these grants became a larger and larger proportion of the total funds, until to-day the voluntary contributions form a negligible part of the whole (less than 2 per cent). Thus school feeding has gradually, almost imperceptibly, ceased to be a voluntary activity of charitable organizations and persons, and become a duty of local public authorities.

The *caisses des écoles* appoint canteen committees to supervise the school feeding in the various districts. As in England, the meal chiefly served is midday dinner, though occasionally soup is given in the morning to children whose poverty and undernourishment is particularly obvious. In 1921 the number of those receiving meals was about 187,000. Of these, approximately two-thirds had their meals free, the rest paying for the cost of the food but not for the service or the equipment. Since 1921 the number receiving meals has, as in England, greatly increased.

One of the most salutary characteristics of the French system is the absence of 'the charity atmosphere so prevalent in the English schools'. Mr. J. C. Gebhart, the American investi-

gator, in stressing this fact, gives the following explanation: 'This is avoided by an ingenious system of tickets. On entering the room each child passes through a booth where he secures a ticket. Those who can, pay; those who cannot are admitted free, but receive a ticket the same as those who pay. The home conditions of the indigent child are then investigated, and if it is found that the parents really cannot afford to pay, he is given a ticket each day without further comment. In this way the children are kept in ignorance of those who pay and those who do not.'

In other respects the French system of school feeding does not differ materially from the English. But it is important to note that the English and French systems represent two types of organization for dealing with malnutrition of children of school age. In England there is a centralized State organization under the Board of Education in conjunction with the Ministry of Health. The Board lays down general principles and supervises, controls, and inspects the work of the local education authorities; while the financing of the system also is very largely undertaken by the central government. The local authorities are granted only so much autonomy as is consistent with a fundamental uniformity of administration. In France, on the other hand, the State as such, has no concern with the system of school feeding. The whole responsibility, financial and administrative, is left to the local authorities, which, urged on by the early voluntary work in this field, have organized a highly developed system of meals in schools. They bear also, as we have seen, more than 98 per cent of the cost, the remainder being made up by voluntary contributions.

One or other of these two systems has been adopted by all the countries in which the problem of malnutrition among school children is being dealt with by public authorities. It would be merely repetitious to describe the working of the system elsewhere, nor would it be worth while since in most countries the organization of school feeding is in a far more rudimentary condition than in England and France. It may, however, be of interest to mention one further example of school feeding which has been particularly effective.

According to the League of Nations' report on *Nutrition in Various Countries*, 'the *Riga* municipality has arranged for hot

meals to be distributed to pupils in all elementary schools. In 1935, the total number of elementary school children in Riga was 30,740, of whom 19,397 shared these common meals. Of these 19,397 school children, 11,407 were fed free at the cost of the municipality. The total number of rations distributed in 1935 was 3,315,014, of which 1,902,192 were given free. The cost of a ration is about 15 centimes. The distribution of hot meals costs the Riga municipality about 300,000 lats* a year. The school board decides when meals are to be given free.' The case of Riga as thus described must be almost unique in Europe. It will be observed that nearly two-thirds of all the elementary schoolchildren in the city receive school meals, and that considerably more than one-third receive them free. If this is compared with England where, we have seen, only about one-twentieth of the children receive meals, whether free or at a low price, it will be seen how admirable the system is. Doubtless the extreme poverty of the Latvian people makes the problem of malnutrition even more pressing than it is in England. Still, need, however great, does not always compel governments to action, and the Riga municipality is to be congratulated on its thoroughness.

In the *Soviet Union*, the organization of the nutrition of school children, like that of mothers and infants, is chiefly remarkable for its thoroughness and wide extent. The ultimate plan, to which the actual organization is approximating as quickly as the resources of the Soviet Union will allow, is that all children of whatever age are to be provided with restaurant meals at least twice, and later perhaps three times during the day, whether in the school period or not. This ideal has not yet been attained; but already in the cities at least, and particularly in Leningrad, which appears to be in advance of other cities in matters of nutrition, practically all the children receive at least one hot meal daily in their school dining-rooms. 'The regulations prescribe that they should have at all events a mid-morning lunch and a hot midday meal,' say Clark and Brinton; and they add: 'As far as we could see, this is carried out.' The younger children are already provided with three meals daily; and there are special dining-rooms for delicate children. About 20 per cent of the meals are given free, and the rest at

* £1 = 25·22 lats.

an extremely low price. Clark and Brinton testify that the kitchens and dining-rooms in the newer schools, at least, are fully mechanized and tastefully decorated, tables for four or six being provided. The diets served are practical but scientifically planned to meet the nutritional needs of the children.

It will be seen at a glance that the Soviet system of school feeding by far surpasses anything known in the most advanced countries of the West; and this although it is admitted by the Soviet authorities that the system is still far from having attained the high aim proposed for it. Clearly, there is much to be learnt by a close study of this organization.

Nutrition of Adults

Undernourishment and malnutrition, as we have seen, are phenomena not confined to special categories of the population nor to backward or undeveloped countries. Surveys of the leading industrial countries of the Western world have shown conclusively that malnutrition is a scourge which affects large classes of the population. It will be remembered that according to Sir John Orr at least 50 per cent of the population of England suffer to some extent from inadequate nutrition. The physique of the adult population shows signs of deterioration. It is estimated that workers insured under the National Health Insurance lose on an average 28 days work per annum through illness compared with 16·5 days some fifteen years ago. The rejection of nearly 47 per cent of the recruits who recently offered themselves for service was a revelation.

In spite of these facts, however, no government, except that of the Soviet Union, has thought it worth while to take measures to ensure adequate nutrition to the bulk of the adult population. Such measures as exist are either confined to special cases, limited to comparatively small categories of the population, or designed only to meet a special emergency. There are several reasons for this neglect. In the first place, unlike malnutrition among schoolchildren and, to a lesser extent, among infants and mothers, which is constantly being forced on the notice of the authorities, malnutrition among the working population is comparatively easy to ignore and even to deny. Secondly it is clearly far more difficult to deal with

the problem on such a huge scale as is obviously required in the case of the adult population; the expenditure involved is probably too great to be willingly undertaken by any of the governments at present in power. Finally, it would seem very doubtful whether the problem is in fact capable of solution under the present organization of social economy. Under this system the only permanent cure would be the elimination of unemployment and a steady and very perceptible rise in the wages of the working class. It does not appear likely that either of these things will take place so long as the welfare of the community as a whole is sacrificed to individual interests under *laisser faire* conditions in economic affairs. Meanwhile, the economic depression and the chronic crisis in agriculture have brought the problem to the fore, and it is worth while to notice briefly some of the methods which have been adopted to deal with the worst manifestations.

The Federal Government of the *United States*, for example, attempted to deal with the agricultural and unemployment crises at the same time. It bought large quantities of agricultural products (meat, milk, butter, flour, fruit, etc.) from the farmers who were finding it difficult to dispose of them at reasonable prices, and distributed them, through the various State relief agencies, to the unemployed. The same thing has been done in *Austria*, and in some other countries. Clearly, however, this is not a measure to *improve* the nutrition of the adult population, but merely to prevent the actual starvation of the unemployed. Another method adopted in the United States of America, Austria, Italy, and other countries, is the provision not of raw food but of actual meals to the unemployed. Thus, in *Italy*, 'soup kitchens' have been set up in various towns, which give one meal a day to persons 'whose circumstances entitle them to receive it.' These meals are generally equivalent to 1,300 calories, or rather less than one-half the amount of energy needed daily. The following statistics show the extent of 'adult feeding' in the Fascist régime: 'In

[illegible]

in Italy this work has been carried out on a fairly large scale.

Another, and more permanent, method of ensuring better

nutrition to the working class is by means of canteens in the factories and work places where meals are, served to the employees at a moderate price, or in certain cases free of charge. This is not, of course, a measure undertaken by the State, but by the private initiative of factory owners. Some States, however, appear to encourage the practice. In Italy, the factory canteens 'enable the workers to obtain an ample and well-prepared hot meal at a very low cost served during the mid-day interval in appropriate and comfortable premises. Workers are thus enabled to recover the calories necessary for further productive work. These canteens are to be found in almost all large and medium-sized undertakings, some of which themselves issue hot soup at their own cost. Other canteens, on the other hand, are almost entirely managed by the local workers' union. Such, for example, is the case of the canteens of the General Electricity Company at Milan or the harbour workers at Genoa.' There is no evidence to show whether or not this system has in fact done anything to raise the standard of nutrition among the workers for whom it is designed. In any event, its scope, even if it were universal in the factories, would not be very wide, since the majority of the Italian population are peasants.

Perhaps the most efficient method of dealing with the problem of adult nutrition, except that in the U.S.S.R., has been worked out and applied by the Government of *New South Wales*. As we have said above, the crux of the matter is clearly the income of the working class: where this is adequate, the standard of nutrition, while not perfect, will be likely to be more or less satisfactory; where it is inadequate, malnutrition in some form is practically certain to occur. In New South Wales the Government has established a legal minimum wage, and this wage is scientifically calculated in relation to the estimated cost of the primary necessities of life—food, shelter, clothing, fuel, light, and miscellaneous requirements. The dietary scale adopted appears to be worked out with great care and is fairly generous, sufficient anyway to insure the minimum requirements of an adequate diet at least. Clearly, such a system will not work automatically. If for any reason, the other primary requirements can be obtained only at a higher price than that estimated for the basic wage, the wor-

ker's nutrition will suffer in consequence. This possibility is, however, guarded against by fairly frequent revisions of the minimum wage to correspond with changes in the cost of living. The scales of relief paid to the unemployed are calculated in very much the same way, though they are somewhat lower. The weak spot in this system is that the dietary scales are drawn up by authorities who have a far wider knowledge both of the elements of nutritional science and of the possibilities of the market than is possessed by the average housewife. Almost certainly she will be unable to make her income go as far as is estimated by the scales. Nevertheless, the New South Wales system is probably the best that can be devised in the circumstances, because it goes to the root of the problem —*wages*—*instead of merely touching the fringes like most of* the systems in use in other countries.

The only country which has tackled the problem of adult nutrition directly and radically is the *Soviet Union*. Although the Soviet system of 'social feeding' as it is called, could probably work on a large scale only under a planned, that is, socialized, economy, yet the system itself is of such interest that it is worth while describing it in some detail.

In practically all the big factories and collective farms in the U.S.S.R. communal dining-rooms have been established where the workers and their families, if they wish to, can obtain their meals. For the most part the dining-rooms, like the factories themselves, are controlled by the State; others, and especially those on the collective farms, are under the control of the co-operative societies. In both cases, elective committees of workers have a general power of supervision, and it is often on the initiative of these committees that extensive alterations and improvements are made. Though there is naturally a good deal of variation in the efficiency and attractiveness of these restaurants, yet with the increasing prosperity of the Soviet Union they tend to become progressively better organized and more pleasantly appointed.

The kitchens which serve the restaurants are often highly mechanized and fitted with the most modern devices, both for cooking and for preserving food. The diet served is very carefully worked out on scientific principles to meet the nutritional requirements of the workers. Great attention is paid also to its

palatability. As we had occasion to mention one department of the Institute of Nutrition is devoted to the study of methods of cooking for large numbers. Various sauces and condiments have been devised which combine pleasantness of taste with definite nutritional value; and these are widely used. The diet is as varied as possible. We have already seen that many of these factory restaurants have special rooms in which various therapeutic diets are served.

The price of the meals is reasonable. It is estimated that they cost considerably less than an equally nutritious meal in the home could be procured for. Also they are more palatable and more varied than any but the best housewife could prepare. Finally—and this is one of their chief advantages—they relieve women of much of the drudgery of housework.

To cater for the smaller factories, workshops, and various institutions which do not have facilities of their own, 'kitchen factories' have been established, which are designed as large modern food plants. Here meals can either be cooked to serve in the restaurants which are attached to the plants themselves, or they can be partially prepared and despatched to the places where they will be eaten. In Leningrad alone there are 27 such kitchen factories, and many more throughout the country. A few of them are very large indeed, and prepare 200,000 dishes, wholly or partly cooked, in a day.

We need not enquire here how far such a system of social feeding is applicable to other countries. Its advantages—economy at once of resources, time, and labour, scientific planning of diet, hygienic conditions both of food preparation and of food consumption, and the increased freedom of women from household drudgery—are obvious. There can be no doubt that those who are faced with the practical problem of improving the nutrition of the working class will find much to learn from the Russian experiment.

It should be clear even from the sketch presented in this chapter that the problem of nutrition both in its theoretical and its practical aspects has begun seriously to attract the attention of the governments of many of the advanced Western states. Material of great interest and importance has been collected on an international scale by the League of Nations; re-

search of real value is being conducted by various governments into different branches of nutritional science; and a certain beginning at least has been made in the application of the 'newer knowledge of nutrition' to special sections of the community. The advance of our knowledge of the scientific principles of nutrition and the increasing realization, supported by extensive surveys and the accumulation of reliable data, that undernourishment and malnutrition are extremely widespread in their incidence and disastrous in their effects, make it impossible for governments any longer to ignore a problem of such vital importance. Steps are everywhere being taken in the West to deal with the situation. If many of the measures adopted are hopelessly inadequate, the experience of the Soviet Union shows clearly that a co-ordinated and planned nutritional policy for the entire population can be of the utmost benefit. It is doubtful whether, under the present economic system, such a policy could be introduced into India; but in the next chapter we shall examine what practical steps could even now be taken to alleviate the widespread suffering, the moral and physical deterioration, caused by malnutrition.

CHAPTER EIGHT

Facing the Problems in India



Overcoming Inertia

In attempting to improve the state of nutrition of our people, we Indians are indeed faced with difficulties far greater and more complex than those in most of the advanced countries. The magnitude and character of the poverty which afflicts the greater part of the population is unparalleled; it imprisons them in a vicious circle from which they can find no way of escape. A great deal of unnecessary suffering among them may be attributed to dietary prejudices and social customs. But at the root of all the fundamental problems relating to their welfare lies the dead weight of inertia. Because of the circumstances in which they live, the masses have developed a fatalistic quietism. Moneylenders, landlords, traders, priests, and hosts of others take away the fruits of their labours, while they cannot provide themselves with the essential requisites of life; the State and vested interests of all descriptions flourish, while the environment and physique of the farming population and the working class deteriorate; the circumstances which are making India prosperous are also releasing forces which create poverty among the bulk of its population; and the masses of the greater part of the world are becoming conscious of economic and social maladjustments, while in India they cannot even say *No* to those who exploit them.

The recurrence of famines, floods, and pestilences, the inability to cope with the circumstances which relentlessly expose them to exploitation, the depressing environment which surrounds their daily life, the submission to all forms of social

tyranny—all these have inevitably led to a pessimistic view of life. It is the overwhelming sense of helplessness that breeds the spirit of resignation to fate and paralyses the will to live; despair has engendered such perverse concepts of life that the masses regard existence itself as an evil. To them the docility with which they tolerate the social and economic disabilities imposed on them has become a symbol of spirituality.

So long as this defeatist attitude towards life dominates the outlook of the masses, the impetus to improve their conditions of life will be found lacking. Therefore it is this attitude which has to be changed if India is to arrest the symptoms of decay so conspicuous among the population. But, as Lord Hailey observes, the Government 'have never deliberately attempted to effect that change in the psychology of the peasant, and in his social and personal habits, without which it is impossible materially to improve his conditions of life.'

That task cannot be fulfilled by mere philanthropy or by organizing here and there a number of 'welfare centres'. What is needed is the kind of awakening of social consciousness which brings about a determined will to alter the scale of values hitherto dominating our social and economic relations. It cannot be denied that in matters relating to the health and nutrition of the greater part of our population, the privileged classes have shown nothing but complacency; otherwise things would not have deteriorated to the point of such degrading conditions. To my mind, this complacent attitude and almost callous indifference towards the need of a fundamental change in the outlook on life may also be traced to 'intelligentsia-pessimism' (to quote a phrase used by Lenin). That coherent social force which alone can weld together heterogeneous interests has not as yet emanated from our political agitation. The horizon of our social life remains narrow and that is why, as one of our religious teachers lamented, India has done so little for the welfare of the masses in comparison with the social achievements of the West.

It may appear strange that this should be so, but India's spirituality has not enabled her to realize the value of existence itself. She has lost the capacity of transforming or resisting the environment of life—the process by which a people develops the dynamic quality and attains the consciousness of nation-

hood. Our failure in this respect is due to a lack of spiritual endeavour; yet we are regarded as a people whose life centres round religion; our vision transcends the world of sense and rests upon the world of spirit. But we may ask ourselves, how is it that our life does not seem to move towards a creative advance? If *Dharma* is to indicate the way of life, why are we lost in chaos and confusion?

The truth is, the other-worldliness which masquerades under the cloak of spirituality is in reality a symptom of defeatism. The Aryan spirit which once delighted in expressing itself in colourful creative activities by fully acknowledging the world of our senses has become suspicious of life itself; originally it did not seek refuge in a renunciation which distorts the fundamental spiritual values of life by presenting them as antagonistic to the world of reality. If we do not see life with sanity to-day, it is because we distrust its urge and devise elaborate ideologies to suppress it; if we focus our gaze upon life beyond, it is because we fail to recognize the rhythm of life here which manifests itself in a 'plurality of forces'. Let the blunt truth be told: we shall never be able to solve the complexities of the problems of health and nutrition in India so long as the spirit of resignation to fate among the masses and of the spirit of complacency among the privileged classes are not overcome by a nation-wide crusade against malnutrition and ill-health; for the crux of the problem is to have the desire for 'better living'—the desire which springs from the realization of the value of life.

But when the need of such a crusade against disease and devitalization is so urgent, it is tragic that leaders of Indian communities cannot yet sink their differences over issues which are of minor importance. Whatever rivalries may exist among them in the sphere of political and social life, it should be obvious to them that in poverty, in sickness, in servitude, in the misery of existence they have a common danger. The problem of health and nutrition thus transcends the barriers of caste, colour, and creed; and in the task of rescuing the great bulk of their countrymen from the perilous status of poverty, there is no room for communal and party strife.

Problem of Overpopulation

The problem of population in India has recently attracted much attention, and the opinion is frequently expressed that the appalling poverty and undernourishment of the Indian masses can never be overcome if the population continues to increase at its present rate. It is argued that by 1941 the numbers of the population will have caught up with the available food supply, and that the grim Malthusian law of population,* whereby numbers are limited by starvation and want, will begin to demonstrate its validity in India. Those who argue in this way point to the fact that between 1921 and 1931 the *population rose by 50,000,000—more than the entire population* of the United Kingdom. It is added that the rate of increase during the present census decade seems likely to be at least as high, thus bringing the total population to the enormous figure of 400,000,000. The argument is even put forward, on the basis of these facts, that it would be dangerous to do anything that would have the effect of raising agricultural production, or improving the health and social services. An increase in the food supply of the people, or a reduction of morbidity and an improvement in housing and sanitary conditions would merely have the effect of still further raising the birth-rate, since, according to Malthus' law, population always has a tendency to increase up to the limit where it is checked by actual starvation. This depressing conclusion, though it would seem to be a confession of defeat in developing potential resources of food supply through the application of science, is yet maintained by many eminent authorities.

In our opinion, however, *the whole argument is based on* completely false reasoning. In the first place, the figures of

* Malthus wrote: 'In an endeavour to raise the proportion of quantity of provisions to the number of consumers in any country our attention would naturally be first directed to the increasing of the absolute quantity of provisions; but finding that, as fast as we did this, the number of consumers more than kept pace with it, and that with all our exertions we were still as far as ever behind, we should be convinced that our efforts [illegible]

the food.' Malthus, [illegible]

population, though unassailable in themselves, are not nearly so alarming as they are made out to be. Thus the rate of percentage increase of the population of India during the decade 1921 to 1931 was 10·6. If we compare this figure with the rate of increase of the population of England, we find that, although for the corresponding decade the Indian figure is nearly twice as great as the English, yet for every decade of the nineteenth century the rate of increase in England was greater, in some cases almost twice as great, as the present rate in India. Throughout the nineteenth century the rate of increase never fell so low as 10·6: the lowest figure is 11·7, while the highest, for the decade 1811 to 1821, is as great as 18·1. The rate of increase of the population of England has fallen sharply during the twentieth century; even so the population of England has increased during the last 50 years by 53·8 per cent as compared [illegible] population.* Those who find in India's overpopulation a primary cause of poverty and chronic malnutrition and tell us that nothing could really be done unless the 'devastating torrent of babies' is held in check, do not seem to realize that our agricultural production has not as yet received deliberate and sustained application of technological knowledge and that no alarm can be justified while we are still remiss in drawing from our land all that agricultural science can achieve.

The statement that the population will by 1941 have caught up with the available food supply, is based on the tacit assumption that, in the intervening period, the agricultural production will not in fact have materially increased. Now it may be admitted in theory that if the food supply remains stationary, a time will come, perhaps in 1941, perhaps later—the available figures are not in our opinion sufficiently precise to make accurate prediction possible—when the population will in fact catch up with the food supply. The law of diminishing returns, upon which Malthus based his predictions, will ultimately hold good in India as elsewhere. But when we inquire why this law did not begin to operate in England as quickly as Malthus expected, the answer immediately presents itself: because the

* See Appendix II.

structure of productive economy, both in agriculture and industry, adapted itself to the increasing population. Now the agrarian economy of India is considerably more antiquated and defective than was that of England in the time of Malthus. But to assume that Indian agriculture cannot be brought up to a level of efficiency high enough to provide for a population that is not increasing at a disproportionate rate, is either to deny the possibility of normal progress in India or to condemn the economic policy of our rulers as inadequate and reactionary. It is undeniable that the pivot of that policy of the Government has been centred rather upon the requirements of a commercial nation than upon the basic needs of the Indian peoples. That is why no *rational* reconstruction of agricultural industry has yet been undertaken and no substantial progress is made towards abating the risk of the pressure of population upon the means of subsistence.

Be that as it may, every effort should now be concentrated on reorganizing the semi-feudal land system with its tendency to the progressive fragmentation of holdings and the increasing concentration of enormous tracts of land in the hands of a few who use it not to increase the food supply of the population but for reaping a harvest of rent and various forms of illegal exactions (nazar). Revenue farming, which first developed during the Moghul rule, has been stabilized under organized capitalist economy. We have no space here for discussions upon what fundamental alterations in the economic system are necessary before agricultural practice in India can be benefited by the application of technological knowledge. We would only point out that agrarian reform in India is overdue and that the time for piecemeal adjustments has lapsed. The incompetence of our agriculture is largely due to our inability to adapt it to the changing circumstances of a scientific and experimental age. The nation's food supply thus remains in the hands of those who have neither access to technical and material equipment nor the guidance of the 'directed economy' of a government particularly concerned with the health and nutrition of the people. It is in this state of affairs that the Malthusian spectre looms so large on the horizon and disturbs some of our sociologists.

The argument that an increase in the food supply and an

improvement in the health and social conditions of the people would merely tend still further to increase the population, may be dismissed in a few words. This argument, based on Malthus, has not in fact been confirmed by experience. Thus, during the first three decades of the twentieth century the food supply of England and Europe generally has increased, yet the rate of increase of the population in all European countries except the U.S.S.R. has been rapidly decreasing. An improvement in the social conditions and standards of living of the people, moreover, far from having a tendency to increase the birth-rate, would seem to have the opposite effect: people do not wish to endanger their standard of living or that of their children by having large families. For example, it is found that the birth-rate among the Brahmins of Madras city is practically equal to the birth-rate among the Europeans; but the rate is nearly double among the lowest group in the social scale. The further emancipation of women and the spread of education, particularly with the discovery of methods of contraception, a knowledge of which it should be the policy of enlightened education to spread, especially in India where infant and maternal mortality is so high, would have the effect of still further decreasing the size of the family: educated parents, wishing to ensure the education of their children, will not have any more children than they can afford to educate.

To sum up: while admitting that, if the food supply remains at its present level, there is a danger that in the near future the population will catch up with it, we deny first that the rate of increase in population is in itself alarming, and second that there is any reason why the food supply should not be very greatly increased. We see the solution of the population problem in India not in any direct attempts to limit the population, but in a reorientation of the agricultural policy supported by a corresponding reorganization of other branches of economic structure, and in a general improvement of the standard of living of the people.

Nutrition and Agriculture

The underlying problems of nutrition have obviously a close relationship with those of agriculture and animal husbandry. One of the main features of agriculture in India is that the

crops grown are principally those that supply the staple foodstuffs, mostly cereals and pulse, of the bulk of the population. And yet it seems paradoxical that there should be so much chronic starvation and widespread malnutrition in the country.

Let it be frankly stated that until recently agriculture in India has never been seriously thought of as a vital industry. It pays the tax on land, which is the main source of revenue for the Government; it exports certain raw materials for European industries and helps to balance the finance of a debtor country; it supplies cotton, jute, oilseed, tea and other raw materials to build up industries in India and abroad; but it does not provide the tillers of soil, and those who depend on them, with adequate and proper nutrition; nor, indeed, does it help them to mitigate the poverty which is the basic cause of malnutrition.

The nature of the problems which to-day confront Indian agriculture is rendered complicated by our social, economic, and political circumstances. They have not allowed the prudent use of our natural resources. The soil shows signs of exhaustion, and consequently some of our most urgent agricultural problems centre round the improvement of soil conditions. Deficiencies of essential plant foods such as nitrogen, phosphorus, and lime, soil acidity, soil erosion, inefficient methods of tillage, lack of a system of proper rotation suitable to the respective zones, improper utilization of irrigation facilities, the reckless waste of farmyard manure—these are problems which must be faced in order to enable Indian agriculture technically to meet the requirements of health and nutrition of our people. The deplorable state of animal husbandry offers a formidable obstacle to the improvement of Indian diets. Cattle are ill-fed because the quality of the grass is inferior; men are undernourished because milk supply is inadequate.

Since Indian agriculture is in a backward state and since the state of nutrition of the bulk of the Indian population is far below the normal requirements, the problems implied in the proposal of 'marrying agriculture and health'—the phrase used by Mr. S. M. Bruce of Australia at the Assembly of the League of Nations in 1935—have a special significance for India. It means that agricultural policy, research, and administration must be based primarily upon the dietary requirements of the

people; it means that the State must take adequate measures not only to explore the food resources of the country, but to control their distribution in the interest of the consumer; and it means that no time should be lost in effecting a reorientation of agricultural industry if the nutrition and health of a very large proportion of the Indian peoples are to make a substantial improvement.

The initial step towards the solution of this depressing state of nutrition in India would be to increase the productivity of the soil. Our land could yield at least twice or three times as much human food as it does at present. While in some of the Western countries it was considered expedient to adopt measures to decrease production, the need of India is to enhance agricultural productivity by removing the barriers which stand in the way of assimilating the advances of scientific research in agricultural economy. The application of the sciences of chemistry, genetics, pest control, and mechanics, together with the development of modern transport, can ensure abundance of food supply. The epigram—poverty in the midst of plenty—is not at the moment applicable to India, since the level of her agricultural production is far below its potentialities. It is truly said that 'India is a rich country inhabited by a poor people'.

What is required is to release the means of production and distribution from the grip of an economic system operating in India under the combined forces of feudalism and capitalism. That there can be no real solution of the problem of nutrition *within* that system is clear from what we witness in the advanced countries of the West. Although the nature and magnitude of undernourishment and malnutrition there differ from the conditions obtaining in India, the fact that the crisis of under-consumption of essential foodstuffs is so widespread among a great part of their peoples should be a lesson for India.

In most of the advanced countries of the West the application of science and [illegible]

there do exist striking deficiencies in the diet of a considerable proportion of the peoples. Does this not force us to conclude that man has been unable to use the accumulated knowledge of science to his *real* advantage? Does it not raise the funda-

mental question of the disharmony between the application of science and the economic structure? In the sphere of production, science has been successful in overcoming to a large extent the physical limitations of man's environment. He is now able to make the desert blossom or to reclaim waterlogged areas. Or, when he is faced with severe conditions of drought, he is able to mitigate its influence by using deep-rooted crops. By an understanding of the correct balance between the proportions of essential fertilizing constituents, he is able to create favourable soil conditions for crop production. The science of plant breeding has shown him what encouraging results, both in regard to yield and quality, may be obtained in practical agriculture. It is recorded that in the middle of the thirteenth century, the average yield of wheat in Oxfordshire was no more than 5 bushels per acre; but to-day, experiments with high-yielding varieties of wheat at Cambridge show that it is possible to obtain under normal working conditions a yield of 60 bushels per acre as compared with an average of 32 for the United Kingdom. As a result of five years' research, Dutch plant-breeders have produced a strain of sugar cane which has raised the yield of this crop in Java to six tons to the acre. Perhaps Professor Vavilov, the director of the Bureau of Applied Botany in the U.S.S.R. was not unduly optimistic when he declared that the world as a whole could support twenty-five times the present population if the application of science to agricultural practice was unhampered by the illogical politico-economic systems which to-day control agricultural production.

In the work of land reclamation either in a dry zone or in a waterlogged area, the achievements should dissipate the pessimistic view. The success of dry farming in Utah, to cite an instance, is a fact of outstanding importance in the annals of the application of science to agriculture. The large-scale operation as observed by Lord Bledisloe[83] 'in conserving soil moisture by the systematic cultivation of alternate crops of wheat and lucerne, in arid areas with an annual rainfall not exceeding six inches, and in de-alkinizing salt-poisoned land, rendering it available for market-garden crops and fruit, has received all too small public recognition, but it has nevertheless, taken in conjunction with wheat research in Canada, contributed materially to the growing consciousness that the

X. Successful dry farming in Bombay Presidency the crop grown is millet.
By kind permission of Sir John Russell, F.R.S.

XI. The adjoining land where dry farming is not adopted.
By kind permission of Sir John Russell, F.R.S.

world can continue to increase its population at the present rate for at least another century without any risk of food shortage'.

With regard to the protection of crops against pests and parasites, the use of fungicide and insecticide, the methods of inducing hyper-parasitization and the genetic selection of varieties for immunity have already achieved good results in minimizing the loss of crops. It is now possible to eliminate as much as 25 per cent loss of crops from pests by adopting recognized methods of control. But proposals are made for allowing crops to be damaged by pests in order to reduce the food supply! Professor Fernald, an American entomologist, writes: 'Still more recently the value of controlling insects injuring crops of which an excess has been raised, leaving a surplus which cannot be disposed of, has been discussed and the proposal made that attacks of insects on such crops should be allowed to proceed unrestrained to reduce or entirely prevent any surplus.' This is an instance of 'the frustration of science'.

In animal husbandry the progress has not been slow. The knowledge of feeding and breeding livestock has transformed the entire character of husbandry in the advanced countries. There pasturage is improved by selection of nutritive fodder crops; the health of the livestock is guarded by the supply of mineral and other deficiencies in foodstuffs; and the basis of milk and meat production is regulated by scientific management.

All these improvements in various aspects of agriculture have taken place in less than a generation and the trend of agricultural research holds out a further revolution in agricultural practice. But 'it used to be said', laments Sir Daniel Hall, 'that the greatest public benefactor was the man who could make two blades of grass grow where one grew before. Not so to-day, when nations are considering agreements to restrict output and even destroying the products of the soil.' Science and enterprise have performed the miracle of the loaves and fishes, but they do not seem to feed the multitude.

We are not concerned here with the diagnosis of the factors which offer obstacles to the realization of the benefits science holds out to mankind, specially in providing him with an adequate subsistence. The truth is, and we must admit it, that

the growth of agricultural production does not bear a harmonious relationship with the means and methods of distribution. It is being realized that the existing economic system, revolving as it does around the magnet of profit-making, leads to the frustration of all efforts of scientific workers, and produces interminable confusion. Attention must therefore be directed to replacing the *laisser-faire* economy by organized economic planning.

Reorientation of Indian Agriculture

The foremost and dominant consideration in any scheme for economic planning in India must be given to agriculture. We may state categorically that in formulating agricultural policy, the Government have not borne in mind the importance of relating it to the nutritional requirements of the people. Investigations into the quality of the cereals, pulse, and other staple foodstuffs of home consumption have been undertaken in a haphazard fashion. No serious attention has been given to the varieties of millet which enter into the dietaries of millions, and nothing has been done for the improvement of pulse which are, as we have seen, important as sources of vegetable protein.

No single item of foodstuff could be more suitable for India than whole wheat flour. It is liked by all Indian communities although the average consumption per head is only about 23·5 kilograms as against 130 in Europe. But there is every indication of its increased consumption. Once India had a large export trade in wheat, but to-day her market is being thrown open to wheat and milled flour from Australia and other parts of the Empire. Is this not an instance of subordinating India's interests to those of the Empire? What explanation can there be for the lack of initiative on the part of the Indian Governments in increasing the output of wheat or in extending its cultivation? In other wheat-growing countries, the State policy is to give direct assistance for the purpose of stimulating its production. In Great Britain, for instance, the production of this cereal has increased to 1,800,000 tons since the passing of

[illegible]

milk supply and the marketing of foodstuffs are matters which

have been left to their fate, official activity in India is directed, in the main, to the problems affecting jute, cotton, oilseeds, and other raw materials required for the export trade.

We cannot enter upon an analysis of the circumstances under which it has come to pass that agriculture in India barely 'feeds its man'. The framework of this basic industry is medieval and characteristic of feudal economy, and within such a structure, the scope of progress is obviously limited. Only by adopting a constructive agricultural policy can we hope to overcome the handicaps which hinder the development of agriculture in India.

The first obvious step towards planned agriculture in India would be to adopt deliberate measures for increased food production.* 'In considering the problem of nutrition in the East,' Aykroyd says, 'primary emphasis must be placed on quantity,' because a large proportion of the population has hardly more than one poor meal a day. Our agricultural policy must aim at ensuring not only an adequate food supply, but the right kind of food in order to correct the widespread dietary deficiencies of our people. During the last few decades there has been no increase in the acreage under food crops, while that under non-food crops shows an upward tendency. The basis of our crop production is haphazard and uneconomic, and we have not as yet troubled to develop a system of reliable statistics which would be of assistance in regulating crop production with a view to initiating a comprehensive food policy. Conditions precedent to the formulation and adoption of such a policy are twofold, namely, a proper soil survey and a cropping system based upon agrobiological factors. The first would involve mapping the entire regions of our arable fields showing such details (e.g. topography, rainfall, underground water, etc.) as are required for scientific direction of agricultural production; and the second would lead to the maintenance of Nature's equilibrium in respect of the soil and the crop. A planned food policy based upon the interrelated knowledge of all factors of crop production would give far wider scope for the application of agricultural science to farming in India. Land now devoted to inferior cereals, for example, may well be adapted to more nutritive staples. In view of the limited

* See Appendix VI.

possibility of increasing the areas under food crops, the capacity of our arable land for producing the requisite quantity and quality for home consumption should be fully exploited. In those areas where this cannot be done without increasing the per-unit cost of production, a form of subsidy may be introduced with advantage.

Secondly, it is becoming increasingly evident that deliberate measures are overdue for arresting the alarming process of soil impoverishment through cropping, erosion, and ill-planned agriculture. Conditions under which crops are grown determine to a great extent their nutritive value; in other words, foods vary in composition according to the variations of the soil conditions. If, for example, soil is deficient in phosphorus, the crops grown therein contain a low percentage of this element. McCarrison[84] found that rice grown on puddled fields had a nutritive value approximately 33 per cent less than the same rice grown under comparatively dry conditions. Lowland rice contains a low content of vitamin B. Again, land receiving farmyard manure yields wheat and other cereals of greater nutritive value and of higher vitamin potency than those grown in fields treated with chemical fertilizers. Tretiakov in Russia increased the protein of spring wheat from 13·48 to 16·13 per cent and the phosphorus of winter wheat from 0·77 to 1·22 per cent by fertilizing with farmyard manure.* Tests for determining the influence of manurial treatment on the baking quality of English wheat show that the nitrogen content of the cereal increases consistently in proportion to the supply of nitrogenous manures.

It is this correlation between soil conditions and the value of food in certain essential nutrients that constitutes one of the fundamentals of agricultural science. If we neglect to maintain the natural fertility of soil, we expose ourselves not merely to a serious economic loss consequent upon its impoverishment, but to alarming deficiencies in the nutritive substances of our staple foods. The maintenance of soil fertility, what the Danes define as the attempt to preserve 'the joy of the soil', is therefore a problem closely related to that of food supply both in regard to its quantity and quality. It has been rightly said that 'the soil book-keeping of India shows a chronic deficit'. Our

* Communicated to the author by a Polish agricultural expert.

XII. The [illegible]



XIII. Sowing seeds with a country drill.
By kind permission of Indian State Railways Magazine.

land could yield at least twice or three times as much foodstuff as it does at present provided the vicious circle in which agricultural industry has become entangled is broken, and the obvious handicaps to the application of the resources of modern scientific and technical research are removed.

The problem of soil fertility must be an integral part of planned agriculture. Under the prevailing conditions of farming our soil is not adequately replenished by farm wastes and manures. The dung is wasted, as we have seen, as fuel; and with the export of oilseeds and oilcakes we export valuable plant food which should be restored to the soil. A large proportion of our arable land is poor in humus content and with its disappearance the *natural life* of the soil receives a serious setback. That in India the process of soil exhaustion has almost reached a stage known as 'dead level' is indicated by the yield of staple crops, which, in many instances, is practically constant. The standards of efficiency of production may be judged by the fact that India has the lowest out-turn per acre even in normal years. Some of our Western experts propose the introduction of chemical fertilizers in our agricultural practice; but the possibility of their extended use is indeed meagre. Apart from the consideration that they are expensive and do not really rehabilitate the soil, their application tends to diminish the nutritive value of crops. Commenting upon the form of intensive agriculture which encourages the use of chemical fertilizers, Carrel[85] observes: 'Mass production has modified the composition of wheat, eggs, milk, fruit, and butter, although these articles have retained their familiar appearance. Chemical fertilizers, by increasing the abundance of crops without replacing all the exhausted elements of the soil, have indirectly contributed to change the nutritive value of cereal grains and of vegetables.'

Thus the problem of the fertility of our soils resolves into the single consideration of the proper and adequate utilization of farmyard manure. The saving of this invaluable plant nutrient, now largely used as fuel, the use of compost prepared from various waste products, and a judicious system of green-manuring—these positive measures for improving our ill-nourished land demand a nation-wide crusade.

Thirdly, investigations on plant genetics should be systematized and directed to the improvement of the existing varieties

and to the introduction of new ones. The reorientation of Indian agriculture to the nutritional requirements of the people would necessitate setting up in each province a special institute of applied botany whose function would be to study every aspect of the foodstuffs drawn from the plant kingdom. Here, at long last, our neglected fruits and vegetables would be studied. The improvement of the seeds and the varieties of those vegetables, pulse, and fruits whose dietary values are comparatively high would be the chief concern of the institute. Through such an institute we may at last succeed in organizing the distribution of tested seeds.

Indeed, researches on plant genetics and plant ecology hold out a promise of development to which no modern State can be indifferent. In the U.S.S.R. the Department of Applied Botany, which receives an annual endowment of £300,000, collected over 20,000 specimens of peas, beans, and lentils with a view to selecting strains of greater nutritive values than those grown in the Russian soil. Over a thousand workers are engaged in the study of plants of economic importance, and researches are being pursued with the object of doubling the number of chromosomes in plant-cells and so of evolving *larger* sizes of cereals, pulse, and root-vegetables. Cabbage, which is a favourite leafy vegetable of the people, receives special attention by a separate section of the Department of Applied Botany. *The Russian geneticists are also working on strains of quick*-maturing potatoes so that they may be grown even in those regions which otherwise are unsuitable for the crop.

Lastly, the problem of marketing agricultural produce cannot be left out of consideration in any scheme for 'directed agriculture'. It is not, however, merely a question of providing better facilities, or of controlling the prices of commodities. The chief problem of the exploitation of our peasantry lies in the middlemen to whom the primary producers are obliged to sell crops at a price about 25 per cent lower than the usual market-rate and in the deliberate increase of paper money thrown on the buying market by the banking *cum* commercial organizations. During the harvesting seasons, the cash reserves of the banks are heavily drawn upon and the agents of trading concerns traverse the countryside with ready cash for buying agricultural produce.

The quantity of foodstuffs which the cultivator sells or keeps for his own consumption cannot be accurately estimated; but the imperious necessity of meeting his liabilities in cash payments in the harvesting seasons contends with his desire to ensure food supply for himself and his family. In the struggle between the cash demands of the creditors and the stomach of the peasants, the organized interests gain the victory and a great part of the peasantry is left without adequate sustenance even in a normal season of harvests. And he cannot, after meeting the demands of his landlord, moneylender, commission agents, shopkeeper, and a host of other parasitic interests, provide himself with the cash required for the food of his family.

Recently the Government in India have directed their attention to the investigation of our under-developed marketing systems. The outcome of this enquiry may at least result in identifying the sources of the incredible waste involved at almost every stage of distribution. As every form of waste inflates the cost of distribution and enhances the prices of commodities, we hope that the existing disparity between production and consumption may to a certain extent be lessened by deliberate weeding out of a number of parasitic interests which so disastrously affect the market. Ultimate success in the task of organizing agricultural marketing is to be measured by the impetus it offers to production.

Introduction of New Food Crops

Co-ordinated investigations of plant genetics and plant ecology may lead to another important aspect of the relationship between nutrition and agriculture, namely the introduction of new food crops. It is estimated that there are approximately half a million species of plants in the world but only a few hundred of these are cultivated. The discovery and introduction of a new source of food may have far-reaching consequences in social economy, as was the case with the introduction of potatoes in the latter part of the sixteenth century in England;* or of banana in recent years. There are other

* Potatoes were indigenous to South America and were imported into Europe about A.D. 1580. Sir Walter Ralegh was the first to grow potatoes, on his estate near Cork.

instances of the successful introduction of foreign plants into European agriculture and they have often made desirable changes in the diet of the people. The introduction of green salads by Catherine of Aragon, wife of Henry VIII, undoubtedly improved the monotony of English fare. The Mediterranean countries are indebted to the Portuguese for introducing the cultivation of oranges.

One of the essential steps towards the reorientation of agriculture in India then is to explore the possibilities of introducing new food crops. We shall here mention two plants which have already attracted much attention as sources of human nutrition.

Of the new crops which may be successfully introduced into Indian agriculture, the *soya bean* (*Glycine hispida*) is of exceptional importance owing to its nutritive value. It is a leguminous plant known to have been grown from the earliest times in China, Japan, and Java, where the soya bean is an important item in the people's diet. It is rich in good proteins and contains as much as 4·8 per cent of inorganic constituents, mostly phosphates and calcium. In 100 grams of soya bean there are, on an average, 38 gm. proteins, 28 gm. carbohydrates, and 18 gm. fat; and its fuel value is calculated at about 430. Its low starch content makes it a suitable item in the dietary of diabetic and dyspeptic patients. Of the vitamins it is rich in both fat-soluble A and water-soluble B; the latter is, as we have seen, an essential food-factor especially for those who consume polished rice.

The beans are soaked in plain or salted water for about twelve hours and then roasted or boiled. Sprouted beans are used as a fresh vegetable and in Chinese cookery it enters into various dishes. The flour made from this valuable legume contains approximately 40 per cent protein, 20 per cent fat, and 26 per cent carbohydrates and 6 per cent inorganic constituents. Among its other uses, the preparation of milk from soya bean deserves our attention. Dried soya beans (especially yellow varieties) are soaked for a few hours and then crushed into a pulp. This is then boiled with water for about thirty minutes, and the liquid, passed through a fine sieve, is the 'soya bean' milk which is so extensively used in China. Its chemical

and physical properties are somewhat similar to those of cow's milk and it may be used as a good substitute for infant feeding. Soya-bean milk is also recommended for the treatment of digestive disturbances. The precipitated proteins of the milk form a popular article of food known as bean curd (*teou fu*) out of which the Chinese prepare different varieties of cheese.

It is interesting to compare the compositions of vegetable casein prepared from soya bean and peanut.

TABLE XIX*

Percentage Composition of Vegetable Casein

	Soya Bean	*Peanut*
Moisture	11·43	6·14
Ash	2·08	1·37
Fat	0·91	0·47
Total nitrogen	12·25	13·05
Casein nitrogen	78·15	83·26

Ever since the problem of nutrition for industrial and agricultural workers engaged the attention of Europe and America, an attempt has been made to popularize the soya bean and its flour. Berezeller of the Vienna Physiological Institute suggested a recipe for the preparation of bread with soya-bean flour and calculated that its use would save five and a half million pounds annually to the Austrian nation. The United States Army dietician found that a mixture of 80 per cent wheat flour and 20 per cent soya-bean flour yields an excellent bread of good flavour. During the War the bread for the French Army was largely made from soya-bean flour. The Italian Government have recently instructed their health officers to induce the people to use a certain amount of this new flour in the manufacture of polenta and bread. Soya-bean bread has been introduced into the dietary of patients in many European sanitoria for the treatment of tuberculosis.

Soya-bean flour properly mixed with cereals such as rice, wheat, or jowar, would considerably increase the protein content of the usual vegetarian diet in India. This has been attempted in the Presidency of Bombay with imported soya beans; but, although its nutritive value was demonstrated, its introduction as an article of diet met with little or no success.

* From the Chemical Department of Nankai University, Tientsin.

Perhaps the trouble lay in the process of milling, which ought to be so devised that the strong flavour of the soya bean is removed.

In view of the urgent need for the supply of inexpensive nutrients in India, this leguminous crop must claim more attention than it has so far received from the departments of Agriculture and Public Health. The extension of its cultivation offers no formidable difficulties; for it grows in almost all types of soil; it is a hardy plant and resists alike drought, excessive humidity and even light frosts. Its flowers are self-pollenated and consequently its introduction in a new region is completely advantageous. Its yield is better than the other leguminous crops grown in India, as is indicated by the results obtained in field trials in Gujrat and Sind. Determined efforts should now be made throughout India to interest the cultivator in this crop.

The autonomous Indian provinces *now* can help considerably both in the cultivation and use of soya bean by introducing soya flour into the diet of prisons, reformatories, orphanages, and other public institutions. Numerous charitable organizations which undertake to feed the poor may be able to provide sufficient of the essential nutrients at a reasonable cost by popularizing the soya bean. In this matter the leaders of Hindu orthodox communities should exert their influence upon the priests of the temples where large-scale social feeding is a common practice.

Another plant whose cultivation may be extended in India both as a nutritious leafy vegetable and a forage is *lucerne* (*medicago sativa*). Though a native of the temperate regions of Western Asia and the north-western part of Persia, it has been successfully introduced in no less than thirty countries. It is a hardy plant with a long root system and thrives well in deep and well-drained soil. Under irrigation the crop can be introduced in semi-arid regions where the scarcity of fodder is chronic.

Its popularity in the West has been due chiefly to its value as forage. The Moors gave it a name, alfalfa, which means the best fodder, and introduced its cultivation into Spain. From there the crop spread throughout Europe and America. The discovery of its use for human consumption led to research into

the food values of lucerne. It is fairly rich in proteins of a high biological value, especially in the fresh young leaves of the plant; and if the crop is grown in a proper soil, it contains nearly three times as much calcium as milk and twice as much iron as spinach. As regards vitamins, they are relatively abundant in the young plant. Levy and Fox have shown[86] that it is 'an exceptionally rich source of vitamin C'. It is estimated that the *fresh* uncooked lucerne leaves contain five times as much vitamin C as the same weight of orange juice.

Horticulture: Production of Fruits and Vegetables

We have already pointed out that in taking deliberate steps towards increased food production in India, considerable attention must be given to the production of protective foodstuffs. In our study of Indian dietaries, we have indicated how inadequate is the supply of fruits and vegetables, two chief sources of essential nutrients, particularly for a country where the greater part of the population is by habit vegetarian.

Now horticulture is that branch of farming which is devoted to the cultivation of fruits and vegetables; but it has not so far entered into any general scheme of agricultural development in India. Our fruit-growers and market-gardeners receive no substantial direction from the State in regard to seed selection, cultivation, or marketing of produce. In the West, the slogans 'Eat more fruit' or 'Drink more milk' are followed by various enterprises for the production and distribution of fruits and milk, for the fruit-growers and dairymen are so organized that they can successfully arrest the attention of the State. Various measures—such as tariffs, subsidies, efficient transport facilities —are adopted to give the required impetus to production in dairies, vegetable gardens, and orchards.

The supply of fruits and vegetables may be considerably increased by initiating a 'kitchen-garden movement' for the benefit of those who are unable to purchase them in the open market. Such a movement originated in the first instance in the United States under the leadership of Grace Dodge, and had a phenomenal success in popularizing the use of fruits and vegetables for *home* consumption.

A movement somewhat analogous to the provision of allot-

ments in Great Britain has lately been started in Italy with a view to encouraging the production of vegetables and small fruits. In some industrial areas, each worker is given a plot of land to cultivate, but he is not allowed to sell its produce. It is estimated that there are over two million 'family kitchen-gardens' in Italy in the management of which the State Department of Agriculture renders every assistance. The new agrarian reforms in Central and Eastern Europe recognize the necessity of creating such holdings as would provide a small garden to landless labourers and poorer agriculturists and encourage some form of collective action among them, especially in the interests of those who are unable to overcome difficulties in adopting the advanced technique of crop production.

A similar movement is long overdue in India and the initiative must come from landlords in the permanent settlement, and from the State in the Rywatari* areas. For a period of years the garden plots should be given free of rent and their cultivation should be supervised by appropriate agents. In countries where conditions somewhat similar to those obtaining in India prevail, efforts are being made to introduce some form of group cultivation. While the collective cultivation of soil to the extent it has succeeded in the Soviet Union may take time to achieve in India, it should be possible to adapt the practice in the first instance to the production of milk, vegetables, and fruits. At the initial stage, individual ownership may not be eliminated but efforts should be directed to show how collectivist methods of cultivation and farm management serve the interests of the group more effectively than those of single and isolated holders. Immediate fruition of such developments may be delayed but we should remember that in the tradition of using the common pasture, woodlands, and watersheds, etc., our peasantry has an instinctive appreciation of collective economy.

It is not impossible to adopt an organized plan of establishing a number of large vegetable gardens and orchards in selected areas in India. The types of soil not remunerative under a cereal crop may well be brought under the cultivation of suitable fruits and vegetables; or the areas under opium and

* The system of land tenure under which the revenue is paid by the cultivator direct to the Government.

hemp—if the use of these narcotics is greatly reduced—may be made available for this purpose. The importance of adequate [illegible]

articles of food should be discouraged if suitable lands are not available for the cultivation of 'protective' foodstuffs and for increasing milk production.

Animal Husbandry: Production of Milk and Milk-Products

Animal husbandry in India is faced not with the problem of raising meat but with that of increasing milk production sufficiently to meet the needs of a non-flesh-eating people. The condition of dairy farming has therefore a special bearing upon the nutritional requirements of all communities in India. The nature of agricultural economy, the insecurity of land-tenure for herdsmen, shortage of grazing land, poor quality of fodders, [illegible] less, they can no longer be ignored if we are to provide even minimum standard diets for the people of India.

Indian herdsmen are, as a rule, capable and consider the cow a 'sacred' animal.* Its domestication led to the development of agricultural pursuits and provided nourishment. To the Aryan-speaking settlers in India, cattle became a symbol of wealth, and they sought to create a social tradition by instituting certain picturesque rituals, designed to raise this animal in the estimation of the people, thus ensuring its care and maintenance. 'O, Mother cow, you are like my own Mother; you feed me with milk; be always full of milk so that we may live in health: and may disease, illness and discomforts be far from you'—with these words even to-day the cow is greeted by the daughters of Hindu houses.

'Happily for the Hindus,' observes Sir Monier Williams, 'the cow which supplies them with their only animal food—milk

* The Babylonians showed their high regard for the cow by addressing her as 'the mother of the moon'.

and butter—and the ox which helps to till their ground were declared sacred at an early period. Had it not been so, this useful animal might have been exterminated in times of famine.'

But in housing and feeding this object of veneration, our dairymen are now driven to adopt measures which are positively harmful to the animal and render the task of milk production under hygienic conditions almost impossible. Cows are kept tied in wretched hovels and fed with scanty fodder. In the wet season they may obtain additional nourishment by grazing, but in the dry season they starve and lose weight; and the recurring period of starvation during their early years seriously undermines their stamina.

The development of pasturage is one of the essential conditions for any substantial improvement of the cattle in India. The pastures are generally poor in nitrogen and deficient in mineral elements, in consequence of which milk production remains low and the progressive deterioration of breeds goes on unhampered. What results can we possibly expect from selective breeding with our ill-fed or starved cattle? By adopting a better system of feeding and by improving the pastures, the military dairy farms in India have herds of Indian cattle yielding as much as 5,000 pounds of milk in a lactation.

In the first place our immediate task for the improvement of animal husbandry is to determine how the nutritive value of pastures can be improved and what methods may be adopted to offset the widespread mineral deficiencies which lead to malnutrition and disease of cattle. We have already noted that there exists a close relationship between the state of nutrition of milch cows and the nutritive content of the milk. What is more, in some dairy countries, the nutritive value of ensilage has been so much improved that the cost of production of butter-fat is reduced by nearly 30 per cent. The adoption of a system of rotation which includes a leguminous fodder crop may, as recommended by the Royal Commission on Agriculture in India, be helpful towards the solution of our fodder problem. And we would be rendering a real service to mother cow if, instead of aggravating the Hindu-Moslem conflict in defence of her sacredness, both the communities co-operate in popularizing appropriate methods of storage of fodder in rural areas.

Secondly, in view of the fact that the consumption of milk and milk-products is far below what is desirable, and that the conditions of their production are fraught with grave risks of contamination and pollution, the informed public opinion of the country should not remain content until some definite steps are taken to organize the dairy industry as an integral part of agricultural economy in India. The state of our milk supply and of the dairy industry reflects nothing but discredit on a civilized government. The initiative for evolving a satisfactory system must now come from the peoples and their representatives in the legislatures. We do not underestimate the difficulties inherent in the problem, but they are by no means insuperable. What is necessary is the preparedness to formulate a bold policy and the will to carry it out.

In planning the development of our dairy industry, it is essential that regions adapted to dairy farming should be properly surveyed in all their aspects. Each of these regions may then be divided into a number of 'dairy districts' and each of these may be organized on co-operative lines so that the industry may be freed from the grip of outside interests. The security of land tenure for our dairy farmers, the reservation of grazing land, the development of collective economy in milk production and distribution and of mixed farming would lay the foundation of progress of dairying in India. While adopting scientific technique in the methods of production and distribution of dairy products, our aim should be to avoid a large-scale factory system. The difficulties arising from the lack of communications and transport facilities, or from the circumstances which make it impossible to employ scientific technique, should concern those who are now responsible for the welfare of the people.

But it should be realized that no positive advance in the development of the dairy industry is possible without building up high-yielding herds of milch cattle and that by increasing the yield of Indian cattle we may succeed to a great extent in reducing the cost of milk production. It is necessary that every step leading to the improvement of indigenous strains of cattle should now be taken and that the provision of financial assistance for the purpose should be adequate. We cannot suggest a single measure which would contribute more to the solution

of nutritional problems in India than the improvement of the *milk-producing stock of the country.*

Development of Indian Fisheries

We have already referred to fish as a source of animal proteins. The extent to which the protein deficiency in the normal diets of the people may be satisfied by the development of fisheries is shown by Japan. As soon as it was demonstrated that fish was one of the easiest and cheapest means of providing *good* proteins in a densely populated country, where the poverty of the masses would ordinarily limit them to a dietary utterly deficient in necessary proteinous foodstuffs, the Japanese Government lost no time in exploiting this abundant resource which undoubtedly serves to maintain the nutritional balance of the millions in Japan to-day. This consumption of sea products is the chief reason why Japan's imports of land-produced foodstuffs are so comparatively small in spite of the congestion of population. The total value of annual catches in Japan proper is about 250 million yens,* of which 64 per cent is by coastwise fishery, 25 per cent by deep sea fishery, 8 per cent by inland fisheries, and 3 per cent by trawling. From a single motor fishing boat in 1906, the number now exceeds 50,000. The Japanese thus extend their fishing operations to distant seas and have steadily increased their share of the world's total sea fishery production until in 1933 it reached the level of over 35 per cent. Leaving 10 per cent for export, they consumed over 25 per cent of all the sea products taken throughout the world; and with these Japan has built up an extensive industry.

The irregularities in the supply of fish are partially met by canning which has led to the popularity of crabs, lobsters, shrimps, and other kinds of fish so abundant in certain seasons but so susceptible to rapid deterioration unless promptly preserved. The tough and muscular fish (e.g. the skate) are made into a kind of loaf called 'Kamaboka'. Fisheries yield a very useful fertilizer made of dried fish refuse and non-edible fish, which is extensively used in the garden-farms of Japan. By all these means, the fishing industries of the country are well organized and the interests of fishermen are protected by

* 1 yen=24·58d.

efficient trade associations. There are over 4,000 fishery guilds with an aggregate membership of nearly 550,000.

Italy, ever since the advent of the Fascist régime, has succeeded in organizing the fishing industry on a comprehensive scale. The 'grain campaign' initiated by the Government reduced the acreage under pasture and depressed meat production; but the increased dependence of the country upon imports for the supply of meat was not desirable. Consequently the Government turned their attention to fisheries. Measures to protect the interests of fishermen engaged in the industry on a small scale by marketing regulations were taken in nearly 600 centres, and the efficiency of operating in high seas was achieved by organizing corporations which now control over 1,300 motor-ships.

In contrast with the achievements of these two sovereign States where the need of cheap proteinous foods is so urgent, the backward and disorganized condition of fisheries in India illustrates what little concern has been shown by her rulers for developing the food resources of the people. In the province of Bengal where the people have no prejudice against fish and subsist, as we have seen, on a diet dangerously deficient in proteins, the Government took no initiative in the matter of organizing fisheries, although the Japanese had been operating nearly fifty trawlers in the Bay of Bengal. Thirty years ago a special officer was appointed in Bengal to investigate the problem of inland fisheries in the province and at a later period the Government of Bengal and Madras established departments of fisheries, but on the recommendations of the Retrenchment Committee the department in Bengal was abolished. Their record of achievement was disappointing. In Madras, through the efforts of the Department, a considerable advance has been made in the manufacture of fish oil and fish manure (guano) but no substantial development can be recorded either in the methods of fishing or in the condition of the fishermen. While artificial fecundation and hatching enriched fisheries in other countries, these methods do not appear to have had any success under conditions obtaining in Bengal and Madras. No attempts were made to pursue initial experiments and investigations such as are conducted in the countries where fisheries are regarded as an integral part of national food economy.

Even without adopting artificial fecundation, it is possible to enrich Indian fisheries by exercising a strict control over the practices of obstructing the watercourses and thus interfering with the migration of fish to their spawning grounds. It would also be necessary to prevent free spill of rivers, canals, and tidal creeks. It is known that 'weirs and bunds affect fisheries by preventing the ascent of breeding fish to their spawning grounds'; but in laying out most of the irrigation works in India the interests of the fishing industry have been ignored.

The report of an enquiry into the fisheries of Bengal in 1908 states: 'In Europe and America, as well as in Japan, there are very stringent fishery laws having for their object the protection and preservation of fish, the securing of facilities for the *passage of fish to their spawning and feeding grounds, and the* increase of control over fisheries in a various way. Even a sparsely peopled country like Canada has found it necessary to protect its fresh-water fisheries by direct legislative enactments and by Orders in Council having the force of law. In Canada and the United States especially, the combined effects of artificial propagation and judicious protection are apparent in the abundant supply of fresh-water fish which after satisfying local wants allows of large exports being made to other lands. But Bengal presents a very different picture. In spite of a magnificent system and of enormous water surfaces spread over the country, fish is becoming scarcer every day, a result, among other causes, of want of protective legislation.' The report goes on to suggest certain laws to facilitate the migration of fish to and from the breeding-places and recommends that special provision should be made for the control of the main channels and rivers throughout the Province.

'A general extension of fish culture', wrote Sir K. G. Gupta in his official report, 'is to be welcomed not only on its own account as adding to the food supply of the people but also because it will materially help to prevent the dissemination of malaria as the carp greedily devours mosquito larvae. . . .' Certain varieties of fish found in Indian rivers, canals, and tanks are known to be most efficient larvicides. The experiments in breeding and supplying these fish to local bodies for introduction into tanks and cesspools infected with mosquito larvae have already shown satisfactory results.

DEVELOPMENT OF INDIAN FISHERIES

That the potential resources of fisheries in India are vast and capable of great development is now a recognized fact; but in all problems relating to research on edible species, provision of hatcheries in selected areas, organization for the training of fishermen and, finally, marketing, the initiative for their solution must of necessity come from the Government. They should face the problem with that firm resolve that characterizes a nation fully conscious of its nutritional deficiencies. But so long as the *laisser-faire* policy in matters that concern vitally the health and well-being of the people persists, so long as public opinion does not wake up to the realities of the situation, and so long as vested interests either of the Government as in Burma, or of the propertied classes, as in the areas under Permanent Settlements, are allowed to dominate the situation, there can be no hope of any improvement in fishery.

Public opinion in those parts of India where a large portion of the people has no objection to the use of fish, should be aroused in favour of such practical measures as are necessary for the development of fisheries. The fact that fisheries and the fish trade are mostly in the hands of special castes has no doubt added to our difficulties in reconditioning the industry; but these difficulties must be boldly faced. A number of co-operative societies have been started among fisherfolk but they are neither adequate nor efficient for the purpose of overcoming the hostility of vested interests. The educational work among them has been equally disappointing.

One method of approach to the problem of Indian fisheries is to attract industrial enterprise. There is no reason why Indian fish products, such as dried and salted fish, and fish-liver oil should not find a wider place in the world market. Hilsa eggs (*Clupea ilasah*) may be added to the list of caviars; the liver oil of some of our common fish may be found as rich in vitamin as the cod or halibut oil of commerce; and lastly, the internal and external markets for dried and salted fish are capable of greater expansion.

Finally, we must urge upon the Federal and Provincial Governments of India the imperative necessity of developing both coast and river fisheries.

Research, Training, and Propaganda

For the purposes of correct definition and adequate understanding of the problem of human nutrition, the essential steps must be taken in the direction of research and training in order to furnish a broad basis for effective propaganda and action. Educational institutions in most of the advanced countries take an active part, as we have seen, both in research and in the spread of knowledge in regard to nutritional requirements at different ages; and these are associated with various voluntary organizations. In India there are no such facilities for co-ordinated activities at present; but if any significant measure of success is to be assured, it is of the utmost importance that at every stage of the educational system this problem should receive adequate and earnest attention.

Impressed with the urgent need of research and training in matters closely related to human nutrition the Royal Commission on Agriculture in India recommended, ten years ago, the establishment of a Central Institute; but the Government of India took no steps in this direction and left the situation as the Commission found it. In the Pasteur Institute at Coonoor, which owes its inception to the generous donation of an American, Lieut.-Colonel (now Sir) Robert McCarrison, was then carrying on his pioneer investigations into various Indian diets in their relation to health and disease. Those members of the Commission who visited his laboratories and were able to grasp the far-reaching significance of the experiments conducted there realized that the facilities provided by the Indian Research Fund Association were utterly inadequate and that work of such importance should be closely co-ordinated with agricultural research. The fund is administered by the Public Health Commissioner with the Central Government and out of about £90,000 annually spent on the promotion of medical research a sum varying between £6,000 and £7,500 is made available to nutritional research. An additional block grant of £11,250 has recently been ear-marked for widening the scope of nutritional investigations in India.

About three years ago when the subject of human nutrition engaged the attention of the League of Nations, the Govern-

ment of India appointed Dr. W. R. Aykroyd as the Director of the Research Laboratories at Coonoor and an Advisory Committee came into existence in 1936 for the purpose of securing collaboration of medical practitioners, economists, agricultural experts, and other interests in planning nutritional research and propaganda in India.

The other institution directly concerned in the study of human nutrition is the Department of Bio-chemistry in the All-India Institute of Public Health recently established in Calcutta. Both these institutions are now co-operating in a special enquiry into the nutritive value of some 300 common Indian foodstuffs, and already valuable data regarding their energy-bearing and biological values, vitamin content, and inorganic constituents have been accumulated.

It is, of course, realized that food investigations should include not only the determination of nutritive values, but the manifold aspects of production of foodstuffs. They should be carried out in co-operation with the various social and industrial organizations and should above all closely follow the tests of the physiology of nutrition. In India a close investigation into the physiology of nutrition is necessary as the basis of exact research if we wish to ascertain correctly the state of nutrition of the masses. Our knowledge of the basal metabolism of various racial and occupational groups is inadequate and carefully planned investigations should be undertaken in co-operation with the universities, medical and other appropriate institutions.

A French scientist of international fame once suggested to me that India offered a unique opportunity for investigating the problem of low metabolism, because there chronic undernourishment was common and the habit of fasting frequent. Thorough investigations of a large number of people with a low intake of food may throw open a new field of research in the physiology of nutrition, and it is to be hoped that such an inquiry may be undertaken by an international committee under the auspices of the Health Organization of the League of Nations.

We are indebted to Dr. Aykroyd for initiating detailed inquiries into Indian dietaries. About seventeen diets resembling that of the various communities have been tested both by

chemical analysis and feeding experiments with rats. Based upon the results obtained, investigations are being carried out to ascertain the quality and quantity of diets supplied to a number of residential institutions for school children in South India. It is hoped that work of this nature will be extended to other parts of India and will lead to comprehensive dietary surveys of different communities and classes. The scheme of training field workers for the purpose, recently adopted by the Coonoor Institute, would be helpful in organizing diet-surveys on a sound footing. These surveys should not only enable us to make a proper assessment of the relative nutritive values of the dietaries but should reveal many other essential facts to which the problem of 'applied' nutrition is related. It should be possible, for instance, to suggest how the agricultural conditions of a locality may be adjusted to the nutritive requirements of the people and what special measures are necessary to correct serious nutritional deficiencies. In order to obtain a fair index of the dietary conditions prevailing in a given community it is necessary to study a number of social and economic factors governing its life and labour. And with the advance of experience in conducting dietary surveys by skilled nvestigators, it would be possible to evolve systems both for the collection of data and for their critical classification.

The type of dietary survey we suggest should include all possible details of the working-class standard of living. 'To say that a poor diet is a result of poverty is not very helpful. *Poverty must be analysed*,' observes Aykroyd. The business of these surveys should therefore consist of analyses of the system under which poverty multiplies and assumes such a dangerous proportion in India. We shall then have reliable evidence concerning the problem of nutrition and poverty. In Great Britain, Dr. M'Gonigle[87] has shown that a direct correlation exists between wages and death-rate. Families with an income between 25s. and 35s. a week die, for example, at the rate of 25·96 per thousand, and between 65s. and 75s. a week, the rate falls to 13·51; but when the income rises above 75s. a week the death-rate is 11·52 per thousand. Similar facts in regard to the wastage of human life in India as a result of poverty are necessary to arouse public opinion and to bring about a

nation-wide campaign for establishing a legal minimum wage to which we have already referred.

In selecting staffs for research work, care should be taken to engage men with a broad scientific and social outlook. 'The field of nutrition has constantly been handicapped', writes Mellanby,[83] 'because much of the work has been in the hands of narrow specialists—bio-chemists with little or no biological or medical knowledge, and medical men with little or no fundamental bio-chemical or physiological training. By anybody with a wider grasp of physiological, bio-chemical, pathological and clinical subjects, a rich harvest will be gathered.' They must also be fully aware of the peculiar circumstances of the country to which the results of their research have to be applied. It is the application of the well-established results derived from nutritional research to actual practice which is of special importance. The basic needs for optimum health are generally known but the difficulty lies in adjusting them to economic and social circumstances. Indeed those who are concerned with the problem of well-balanced diets for the masses in India would require a great deal of skill in suggesting how, as Aykroyd puts it, sixpence could be made to do the work of a shilling.

But in a country where dietary customs have often a religious bias by which certain foodstuffs are prohibited and others included, where the people are ignorant of the actual food values of the various foodstuffs easily available to them, where both agriculture and animal husbandry are in a primitive stage of development and where the need of corporate action is so urgent—it is obvious that there is great scope for education and propaganda to furnish the driving power that is required to stimulate the minds of the people to creative efforts.

Our primary and secondary schools do not possess any of the essential features for successful nutritional education. Our teachers are untrained even in the rudiments of knowledge of the relation between health and nutrition; our school environment is as a rule depressing and unhygienic; funds available for initiating any planned scheme for health education are meagre, and there are social difficulties in dealing with problems that touch upon habits and customs deeply rooted in communal traditions. But it is imperative that Indian political

leaders should face the problem with courage, and initiate methods which in all civilized countries are regarded as essential for the making of a healthy nation.

Our Provincial Ministries should now concentrate their efforts upon the training of teachers. In all Indian normal schools and other institutions for the training of teachers, the course of studies should include a broad outline of the principles of dietetics and health. The course should be compulsory and its subject-matter should be selected in consultation with the Ministry of Health in the Province. It should be neither 'bookish' in character nor of an advanced technical level. On the one hand, it is not enough for the teacher to know that milk is an ideal food for growth, that it contains 'good' protein as well as some of the essential mineral substances such as calcium and phosphorus, and that it supplies certain vitamins. On the other hand, no attempt should be made to teach all the complexities, for example, of the amino-acid contents of foodstuffs. Methods of keeping records of the weighing and measuring of pupils, technique of explaining the charts, capacity of following such directions as may be given to him by the Ministry of Health, and certain basic knowledge in regard to the management of school gardens should form a part of the curriculum.

For the diffusion of knowledge relating to health and nutrition among the people, we have in Chapter Four offered a few suggestions based upon the fundamental need of reviving the corporate institutions in India. The effectiveness of propaganda designed to ameliorate the conditions of life of the people lies in removing such functional disabilities and insidious influences as have impeded the growth of initiative and responsibility among local bodies. Once we succeed in arresting the disintegration of these nuclei of our indigenous social organization, the task of reaching the masses will be easy. We shall then find the people willing to take their share in financing such measures as are required for the improvement of health, physique, and nutrition. It may then be possible to devise a system of local taxation by which the communities themselves would be trained in the spirit of self-help. An Indian author has truly observed: 'The supreme need of public finance in India under a system of responsible government is for the people to

learn the difficult lesson of self-taxation for the public good. They will never be disciplined in this, so long as taxes are imposed only from above and expended for dimly understood and distant provincial and national purposes. They can be effectively schooled in this discipline only through intensive development of local autonomy, including the right of imposing local rates and duties and expending them for the betterment of their own immediate surroundings.'[89]

Side by side with active collaboration in the research activities of the central institutes, the provinces should initiate and pursue investigations in their own respective spheres through their universities and other appropriate bodies. An integral part of economic studies in each province should consist of diet surveys in selected groups from each community. It should be possible, for example, to take one or more groups in a given area, making specific arrangements to ensure that they have a well-balanced diet for a period of at least a year. Records of such experiments may be effective from the point of view both of research and propaganda. For the correction of any deficiencies and the promotion of better health, the ultimate responsibility now rests with the provinces, and their reliance upon the Central Government is neither feasible nor desirable. In each province there should be a central authority—Food Council—concerned exclusively with all questions pertaining to health and nutrition. Its function should not be merely advisory and it should be empowered to initiate such plans as may be warranted by the special circumstances in particular areas. It should rest with this body to supplement and extend activities of various official and voluntary organizations and also to provide interrelating links between public health service, education, agriculture, industry, and rural reconstruction; it should be empowered to supervise institutional feeding, to inspect factories and shops where foodstuffs are preserved, and to assist the Public Health Department in enforcing pure food acts; as it should not be impracticable for the proposed provincial food council to establish a number of food-stores where the public may obtain food supplies of good quality at a reasonable price.

It is not sufficient to bid governments and politicians to seek means and methods of combating physical ill-health among the

masses of the population. It is essential to our purpose that voluntary organizations should do their part in full measure. The movement for spreading the knowledge of the proper kind of food among the masses can succeed only in so far as it draws within its orbit a band of public-spirited workers. They must be in touch with the people and should be able to advise how their meagre incomes may be economized so that they may consume more milk, fruits, vegetables, and wheat. They should keep a vigilant watch over the flood of useless commodities, such as Japanese goods, cheap utensils, foreign toys, patent medicines of all sorts, gramophones, etc., which find their way to our village markets and fairs. They should impress upon the masses that any unnecessary expenditure is an antisocial act so long as they have to struggle with undernourishment and malnutrition, and that the stress of their conditions of life demands strict economy. The other advantage of voluntary organizations is that through them the public would be kept informed of the actual state of nutrition and the slow and ponderous parliamentary machinery would not be allowed to rest until positive measures are adopted for facing the problem in India.

Then there is the problem of making the necessary financial provision for carrying out all those measures that are necessary to mitigate the ravages of the spectre of malnutrition. With all goodwill and sympathy, the Provincial Legislatures may not be able to find adequate finance for the purpose of taking initiative in raising the general low level of health and nutrition. It is not enough to start Provincial Autonomy with its budgets just balanced and to place the deficit provinces 'on a bare subsistence level' by subventions from the Central Government. Most of the provinces would need a substantial programme of capital expenditure for offering increased facilities for the improvement and expansion of the departments concerned with the welfare of the Indian masses. Personally I am not hopeful of any relief through a reduction in the expenditure on the regular services, defence, maintenance of law and order, courts and general administration. The system of bureaucracy which holds India under its grip does not make for economy.

The reorganization of agriculture alone would need ample resources and the readjustment of economic factors in relation

to farming must of necessity involve a considerable financial strain upon the State. As Sir John Orr put it, the marriage of health and agriculture could not take place 'without the gold wedding ring'. The task of mitigating the suffering and economic loss caused by dietary deficiencies and of building a healthy race has to be undertaken on a comprehensive scale and demands an intensive mobilization of 'men, money, and munition'.

The outstanding responsibility of our public men belonging to all sections of the Indian communities is, therefore, to lend their support to any proposal even though it may involve a certain amount of financial sacrifice on their part. Every possible avenue must be explored for the purpose of financing research, organization, determined campaigns and ameliorative measures in regard to health and nutrition; but the problem of additional taxation has to be viewed with great caution, bearing in mind that the present system is not equitably adjusted in relation to the interests of the consumer. His burden is already excessive; and this being so, it should be the guiding principle of any measure enacted for the purpose of revenue to give our indigent population every possible relief, and to look to those who have been and are benefited by 'prosperous' India for increased taxation. In this connection, the official attitude, as revealed by Sir James Grigg, the Finance Member, in a recent address before the Indian merchants in Bombay is of interest. Referring to the urgent need of reassessing Indian tariffs, he observed: 'The objects of this examination are, so far as the Revenue Tariff is concerned, *first*, to see whether the tariff is fully efficient as a revenue-producing instrument, and *secondly*, to see whether it can be simplified in the interests of the commercial community. I pass over a *third* object, namely, the interests of the consumer, whom it is usually considered bad form to mention in commercial circles, because to do anything substantial for him, would—as I have several times said in the Assembly—cost more money than is likely to be available in the immediate future.'

But now that the supreme responsibility of changing the direction of the financial policy of the Government rests with us, we must remember the mass of people who are undernourished and live in circumstances of extreme poverty. It is

for us to find adequate financial resources for the development of services which are of direct benefit to the masses without increasing their burden. India, however, as Layton points out in the Report of the Indian Statutory Commission, is 'a country in which there are large accumulations of wealth on which the burden of Government rests very lightly'. Those who are now at the helm of public affairs in India must also realize that 'the economic preservation of a people', to quote Engels, 'is based on the principle that every generation pays back fully and with interest the capital spent upon it for education and vocational training. This is effected by its upbringing of a new generation. Upon this *generative foundation* rests the secret of every human economy, and the essence of true national wealth.'

We have attempted in this volume to summarize the knowledge which we possess of the relation of food and health, and have adduced sufficient evidence to show that ill-health among the greater part of the population in India is due to both quantitative and qualitative dietary deficiencies. The slow increase in the total production of food and the backward state of agriculture involve a grave danger of widespread physical deterioration specially among the growing generation. There are two avenues which we must explore if any appreciable advance is to be made in the standards of living for our people as a whole; one is the co-ordination of all efforts towards increased productivity; the other an organized campaign for the elimination of waste of every form which characterizes our economic and social life.

One of the effective means of approaching the problem is of course the application of science to our material needs. In building up our own State in India, nothing is of more importance than serious attempts to incorporate scientific ideas in its administration and constructive activities. No modern State can progress without encouraging a wider and wider application of science to life.

Owing to the vastness of the country, and to the heterogeneous conditions of living of its diverse peoples, the task is not easy. The situation has become so entangled in the peculiar circumstances of our social and economic life that the problem of improving the health and nutrition of the people may even

appear insoluble. But it is our firm conviction that *concerted* action of all concerned in the improvement of the health and well-being of the nation cannot but lessen the gravity of the situation. It may also create a sense of responsibility among the people themselves. Once the masses become courageous enough to challenge the circumstances which bring them to the pitch of misery; once their conditions waken the privileged classes to the realization of the sinister forces which allow the state of health, nutrition, physique, and happiness of the bulk of the people to come to such a pass; and once the balance sheet of social economy is presented without ambiguities—once such awakening comes about, the Governments of the country will not be slow in adopting progressive measures. With us in India it is not merely a question of livelihood; nor do we estimate the health of our people only at its economic value. The deplorable consequences of ill-health and undernourishment lie in arresting the growth of man as a full personality. To quote the words of Carlyle, 'It is not to die, or even to die of hunger, that makes a man wretched; many men have died; all men must die—the last exit of us all is in a fire-chariot of pain. But it is to live miserable we know not why; to work sore and yet gain nothing; to be heart-worn, weary, yet isolated, unrelated, girt in with a cold universal *laissez-faire*.'

APPENDIX I

Maternal Mortality in Some Other Countries of the World (compiled from different sources)

Country	*Maternal Mortality per 1,000 births*
Holland	2·4
France	2·5
Sweden	2·6
Denmark	2·7
Norway	2·7
Italy	2·9
Japan	3·0
England and Wales	4·1
Switzerland	4·5
New Zealand	4·7
Irish Free State	4·8
Australia	5·9
Scotland	6·3
United States of America	8·5

(According to Sir John Megaw of the Indian Medical Service the figure for India exceeds 24 per 1,000 births. The Public Health Commissioner in his latest annual report says that the rate of maternal mortality is 24·5 per 1,000 live births.)

APPENDIX II

Birth and Death Rates in British India (1901–34)

Period	*Birth-rate per mille*	*Death-rate per mille*
1901–10	38	34
1911–20	37	34
1921–30	35	26
1931	35	25
1932	34	22
1933	34	22
1934	33·7	24·8

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APPENDIX III

Milk Production and Consumption in India*

Provinces	*Total Milk Production (in thousands of maunds†)*		*Proportion-contributed by Buffaloes*	*Estimated Daily Production per head of population (in ounces)*	*Estimated Daily Consumption per head of population (in ounces)*
	Cows	*Buffaloes*			
Assam	2,771	628	18·4	1·4	2·2
Bengal	40,283	3,080	7·6	3·1	1·9
Madras	23,112	23,175	50·1	3·6	1·6
Bombay	11,135	12,035	51·9	4·7	4·0
United Provinces	57,262	50,760	46·9	4·7	5·0
Central Provinces	19,745	7,221	26·8	6·1	0·8
Bihar and Orissa	31,913	37,166	53·9	6·4	3·2
Punjab	44,745	78,040	63·6	18·3	9·9
Estimated average for India	378,730	300,090	44·3	8·0	7·0

* The first, second, and third columns are taken from Dr. Norman C. Wright's recent survey (1937); the fourth column is from the Provincial Marketing Surveys and the fifth column is based upon Sir John Megaw's figures. The estimated consumption includes both liquid milk and milk products, expressed in milk equivalents.

† One maund equals about 8 gallons.

APPENDIX IV

Principal Food Crops of India*

Common Name	Scientific Name	Common Name	Scientific Name
Cereals		*Leafy Vegetables*	
Barley	Hordeum vulgare	Cabbage	Brassica oleracea capitata
Kodu	Paspalum scrobiculatum	Coriander	Coriandrum sativum
Maize	Zea mays	Cress	Lepidium sativum
Millet Bajra, Cambu	Pennisetum typhoideum	Curry leaves	Murraya koenigii
Millet Jowar, Cholam	Sorghum vulgare	Fenugreek Leaves	Trigonella foenum-graecum
Ragi	Eleusine coracana	Kalmi Sak	Ipomoea reptans
Rice	Oryza sativa	Lal Sak	Amaranthus gangeticus and A. spinoses
Wheat	Triticum vulgare	Lettuce	Lactuca stiva
		Mint	Mentha viridis
Legumes		Puin Sak	Bassela cardifolia
Black Gram or Mung	Phaseolus mungo	Spinach: Palong Sak	Spinach oleracea
Chick Peas	Cicer arietinum		
Cluster Beans	Cyamopsis psoralioides	*Roots and Tubers*	
Cow Peas	Vigna catjang	Beet	Beta vulgaris
Dried Peas	Pisum sativum	Carrot	Dancus carota
French Beans	Phaseolus vulgaris	Garlic	Allium sativum
Field Bean	Phaseolus radiatus	Kachu	Arum
Green Gram	Dolichos lablab	Onions	Allium cepa
Horse Gram	Dolichos biflorus	Potato	Solanum tuberosum
Khesari	Lathyrus sativus	Radish	Raphanus sativus
Lentils	Lens esculenta	Sweet Potato	Ipomoea batatas
Pigeon Peas or Arhar	Cajanus vidicus	Tapioca	Manihot utilissima
Soya Bean	Glycine hispida	Turnip	Brassica campestris

* For food values, see Health Bulletin No. 23, Nutrition Research Laboratory, Coonoor, India, 1937.

Common Name	Scientific Name	Common Name	Scientific Name
Other Common Vegetables		Custard Apple	Anona reticulata
Bitter Gourd	Momordica charantia	Grape	Vitis vinifera
Brinjal	Solenum melongena	Guava	Psidium guyava
Cauliflower	Brassica oleracea botrytes	Jackfruit	Artocarpus integrifolia
Cluster Beans	Cyamopsis psoralioides	Leechi	Nephelium lit-chi
Cucumber	Cucumis sativas	Lemon	Citrus medica
Drumstick	Moringa oleifera	Mango	Mangifera indica
French Beans	Phaseolus vulgaris	Orange	Citrus aurantium
Green Chillies	Capsicus indicus	Papaya	Carica papaya
Hinche	Enhydra fluctuans	Peach	Amygdalis persica
Gourd	Lagenaria vulgaris	Pear	Pyrus communis
Kurkur	Cucumis melo	Pineapple	Ananas sativas
Lady's Fingers	Hibiscus esculentus	Pomegranate	Punica granatum
Papaya	Carica papaya	Shaddock	Citrus decumana
Patol	Trichonasthes dioca	Tamarind	Tamarindus indicus
Ridge Gourd	Luffa acutangula	Watermelon	Citrullus vulgaris
Snake Gourd	Trichosanthes anguina	*Dried Fruits*	
Sweet Gourd	Cucurbita maxima	Almond	Prunas amygdalis
Tomato	Lycopersicum esculentum	Cashew Nut	Anacardium occidentale
Water Chestnut	Trapa bispinosa	Coconut	Cocus nucifera
White Gourd	Benincasa cerifara	Date	Phoenix dectylifera
Fruits		Figs	Ficus carica
Apple	Pyrus malas	Groundnut	Arachis hypogea
Banana	Musa sapientum	Pistachio nut	Pistacia vera
Banana	Musa paradisiaca	Raisin	Vitis vinifera
Coconut	Cocus nucifera	Walnut	Juglans regia

APPENDIX V

Showing the total Excise Revenue in British India during the years 1912–13 and 1933–4 together with the percentage of total Provincial Receipts in 1933–4 in each Province under Country Spirit, Toddy, Opium, and Hemp Drugs.

Province	*Average Excise Revenue per Head of Population (to the nearest Pie)* 1912–13	*Average Excise Revenue per Head of Population (to the nearest Pie)* 1933–4	*Gross Excise Revenue (in lakhs* of Rupees)* 1912–13	*Gross Excise Revenue (in lakhs* of Rupees)* 1933–4	*Percentage of Total Provincial Receipts in 1933–4 from* Country Spirit	Toddy	Opium and its preparations	Hemp Drugs
	Rs. as. p.	*Rs. as. p.*						
Madras	1 12 9	0 14 9	330·29	429·60	30·5	52·0	8·2	5·0
Bombay Presidency Proper	1 2 0	1 10 11	188·65	335·76	51·43	18·23	7·03	5·86
Sind	0 10 6	0 12 6	23·19	30·31	45·66	00·93	13·76	19·37
Bengal Presidency	0 4 10	0 4 3	137·59	134·63	27·57	12·10	26·02	21·42
Burma	0 13 3	0 9 9	85·21	80·14	6·3	14·1	42·9	—
Bihar and Orissa	0 4 10	0 5 3	104·01	123·87	39·5	19·9	19·3	19·8
United Provinces	0 4 4	0 4 4	126·17	133·39	49·8	5·6	15·5	23·2
Punjab	0 5 2	0 6 5	65·73	102·7	42·4	0·04	32·72	13·36
Central Provinces and Berar	0 12 2	0 5 9	111·20	57·70	43·0	6·0	38·0	10·7
Assam	0 11 9	0 6 5	48·52	35·12	34·45	0·15	53·23	10·76
N.W.F. Province	0 3 8	0 5 5	4·04	8·32	46·27	—	15·98	7·82
Delhi	0 12 2	1 2 11	3·15	6·58	39·8	—	27·05	25·9
Ajmer-Merwara	0 11 3	1 2 11	3·52	6·65	81·35	—	8·57	9·32
Coorg	1 6 7	1 8 4	2·47	2·48	62·10	30·65	0·80	3·63
Baluchistan	0 10 9	1 5 5	2·79	5·49	55·5	—	9·5	12·6
(Total average)	0 8 1	0 8 7	1,236·53	1,492·74				

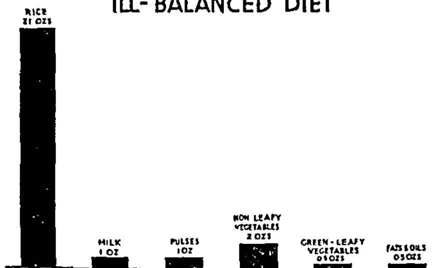
* One lakh equals £75,000.

APPENDIX VI

An Approximate Estimate showing the General Trend of Food Production in India*

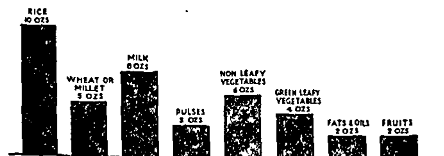
Foodstuffs	1922–3 1923–4	1924–5 1925–6	1926–7 1927–8	1928–9 1929–30	1930–1 1931–2	1932–3 1933–4	1934–5 1935–6
CEREALS (millions of tons)							
Rice	31·0	30·9	29·0	31·6	32·6	31·0	29·0
Wheat	9·9	8·8	8·4	9·5	9·2	9·4	9·6
Jowar	5·8	6·0	6·5	6·9	6·6	6·3	6·3
Bajra	2·3	2·4	2·7	2·4	2·6	2·4	2·6
Maize	2·1	1·8	2·0	2·2	2·3	2·0	2·3
Barley	3·0	2·6	2·3	2·4	2·4	2·4	2·4
PULSE (millions of tons)							
Gram	4·9	4·0	3·6	2·9	3·6	3·6	3·8
SUGAR CANE (millions of tons)	3·2	2·8	3·3	2·7	3·6	4·8	5·5
OILSEEDS (thousands of tons)							
Linseed	498	451	377	351	396	391	404
Rapeseed and Mustard	1,179	1,065	922	1,002	1,006	992	928
Sesam	461	467	479	475	501	546	434
Groundnuts in shell (millions of tons)	1·2	1·6	2·1	2·6	2·5	3·2	2·0

* Figures for pulse other than gram, inferior millet, fruits, and vegetables are not available. I am indebted to the Imperial Council of Agricultural Research for supplying the data from which the table is *composed*.



2600 CALORIES, CORRESPONDING TO AVERAGE ADULT INTAKE PER DAY.

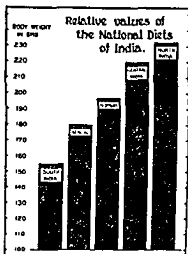
WELL-BALANCED DIET

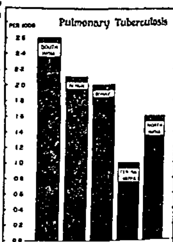


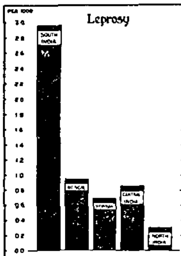
2600 CALORIES, CORRESPONDING TO AVERAGE ADULT INTAKE PER DAY.

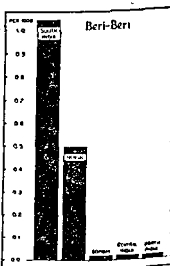
NUTRITION RESEARCH LABORATORIES. I. R. F. A.
COONOOR

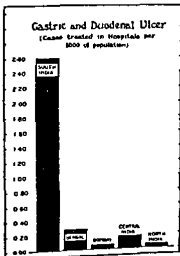
NUTRITIVE VALUES OF DIETS IN COMMON USE IN THE FIVE MAIN DIVISIONS OF INDIA, AS DETERMINED BY FEEDING EXPERIMENTS ON RATS, COMPARED WITH THE FREQUENCY DISTRIBUTION OF CERTAIN DISEASES PER 1000 OF SICK PERSONS IN THESE DIVISIONS.

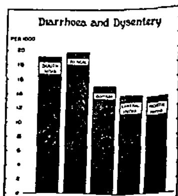












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